THE TENDENCY OF HISTORY

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THE TENDENCY OF HISTORY

BY

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CHAPTER I

THE PROBLEM

THE mechanical theory of the universe governed physical science for three hundred years. Directly succeeding the theological scheme of a universe existing as a unity by the will of an infinite and eternal Creator, it affirmed or assumed the unity and indestructibility of Force or Energy, as a scientific dogma or Law, which was called the Law of the Conservation of Energy. Under this Law the quantity of matter in the universe remained invariable; the sum of movement remained constant; energy was indestructible; "nothing was added; nothing was lost;" nothing was created, nothing was destroyed.

Towards the middle of the nineteenth century,—that is, about 1850,—a new school of physicists appeared in Europe, dating from an Essay on the Motive Power of Heat, published by Sadi Carnot in 1824, and made famous by the names of William Thomson, Lord Kelvin, in England, and of Clausius and Helmholz in Ger-

many, who announced a second law of dynamics. The first law said that Energy was never lost; the second said that it was never saved; that, while the sum of energy in the universe might remain constant,—granting that the universe was a closed box from which nothing could escape,—the higher powers of energy tended always to fall lower, and that this process had no known limit.

The second law was briefly stated by Thomson in a paper "On a Universal Tendency in Nature to the Dissipation of Mechanical Energy," published in October, 1852, which is now as classic as Kepler's or Newton's Laws, and quite as necessary to a scientific education. Quoted exactly from Thomson's "Mathematical and Physical Papers" (Cambridge, 1882, Vol. I, p. 514), the Law of Dissipation runs thus:

"1. There is at present in the material world a universal tendency to the dissipation of mechanical energy.

"2. Any restoration of mechanical energy, without more than an equivalent of dissipation, is impossible in inanimate material processes, and is probably never effected by means of organized matter, either endowed with vegetable life or subjected to the will of an animated creature.

"3. Within a finite period of time past, the earth must have been, and within a finite period of time to

come, the earth must again be, unfit for the habitation of man as at present constituted, unless operations have been, or are to be performed, which are impossible under the laws to which the known operations going on at present in the material world, are subject."

When this young man of twenty-eight thus tossed the universe into the ash-heap, few scientific authorities took him seriously; but after the first gasp of surprise physicists began to give him qualified support which soon became absolute. "This conclusion made much noise," says Ostwald ("L'Énergie," Paris, 1910); "the more because Helmholz and Clausius gave in their adherence to it. We owe to the latter the following formula: 'The Entropy of the Universe tends toward a maximum.'" To physicists, this law of Entropy became "a prodigiously abstract conception," according to the familiar phrase of M. Poincaré; but to the vulgar and ignorant historian it meant only that the ash-heap was constantly increasing in size; while the public understood little and cared less about Entropy, and the literary class knew only that the Newtonian universe, in which they had been cradled, admitted no loss of energy in the solar system, where the planets, at the end of their planetary years, returned exactly to their positions at the beginning. Gravitation showed no waste of energy whatever, except where friction

occurred, but had planets gone off like comets, and never returned, the scholar of 1860 would still have feared to question the scientific dogma which asserted resolutely, without qualification, the fact that nothing in nature was lost. If no other assurance had satisfied him, all doubts were silenced by the famous outburst of eloquence with which Tyndall concluded his Lectures in 1862, on "Heat as a Mode of Motion." Old men can still recall how, after explaining that "the quantity of the solar heat intercepted by the earth is only $\frac{1}{2{,}300{,}000{,}000}$ of the total radiation," Tyndall refrained from telling what became of the heat not intercepted by the earth, and went on to expatiate with enthusiasm on the unity of the universe and its energy:—

"Look at the integrated energies of our world,—the stored power of our coalfields;—our winds and rivers;—our fleets, armies and guns! What are they? They are all generated by a portion of the sun's energy which does not amount to $\frac{1}{2{,}300{,}000{,}000}$ of the whole. This, in fact, is the entire fraction of the sun's force intercepted by the earth, and in reality we convert but a small fraction of this fraction into mechanical energy. Multiplying all our powers by millions of millions, we do not reach the sun's expenditure. And, still notwithstanding this enormous drain, in the lapse of human history we are unable to detect a diminution of his

store. Measured by our largest terrestrial standards, such a reservoir of power is infinite; but it is our privilege to rise above these standards, and to regard the sun himself as a speck in infinite extension,—a mere drop in the universal sea. We analyse the space in which he is immersed, and which is the vehicle of his power. We pass to other systems and other suns, each pouring forth energy like our own, but still without infringement of the law which reveals immutability in the midst of change, which recognises incessant transference and conversion, but neither final gain nor loss. This law generalises the aphorism of Solomon, that there is nothing new under the sun, by teaching us to detect everywhere, under its infinite variety of appearances, the same primeval force. To nature nothing can be added; from nature nothing can be taken away; the sum of her energies is constant, and the utmost man can do in the pursuit of physical truth, or in the application of physical knowledge, is to shift the constituents of the never-varying total, and out of one of them to form another. The law of conservation rigidly excludes both creation and annihilation. Waves may change to ripples and ripples to waves,—magnitude may be substituted for number, and number for magnitude,—asteroids may aggregate to suns, suns may resolve themselves into floræ and faunæ, and floræ and

faunæ melt in air,—the flux of power is eternally the same. It rolls in music through the ages, and all terrestrial energy,—the manifestations of life as well as the display of phenomena, are but the modulations of its rhythm."

This magisterial tone irritated some of the new physicists to the point of hinting that Tyndall deliberately misstated the facts of physics, for fear lest some one should drive him into a logical snare, ending in the necessity of admitting a Creation. In flat contradiction to Tyndall, Kelvin and Tait affirmed that "the same primeval force" could never be detected,—much less recovered; that all nature's energies were slowly converting themselves into heat and vanishing in space, until, at the last, nothing would be left except a dead ocean of energy at its lowest possible level,—say of heat at 1° Centigrade, or—272° C. below freezing point of water,—and incapable of doing any work whatever, since work could be done only by a fall of tension, as water does work in falling to sea-level.

Between such authorities the unscientific student could not interfere. Naturally, all his sympathies were with Tyndall. The idea that the entire sidereal universe could have gone on for eternity dissipating energy, and never restoring it, seemed, at the least, unreasonable; while the astronomers drew up lists of nebulæ by

hundreds in the very act of generating universes, and the geologists showered the theory with rocks in order to show that the sun had already reached an age many times greater than Thomson was willing to allow it.

No one knew, although every one explained what had caused the inequalities of energy; least of all could the historian of human society assert or deny that energy could be created or could not be destroyed. The subject was beyond his province. Since the Church had lost its authority, the historian's field had shrunk into narrow limits of rigorously human action; but, strictly within those limits, he was clear that the energy with which history had to deal could not be reduced directly to a mechanical or physico-chemical process. He was therefore obliged either to deny that social energy was an energy at all; or to assert that it was an energy independent of physical laws. Yet how could he deny that social energy was a true form of energy when he had no reason for existence, as professor, except to describe and discuss its acts? He could neither doubt nor dispute its existence without putting an end to his own; and therefore he was of necessity a Vitalist, or adherent of the doctrine that Vital Energy was independent of mechanical law. Vitalists are of many kinds.

"In former times a special force was adduced,—the

force of life. More recently when many phenomena of plant life had been successfully reduced to simple chemical and mechanical processes, this vital force was derided and effaced from the list of natural agencies. But by what name shall we now designate that force in nature which is liable to perish while the protoplasm suffers no physical alteration? . . . This force in nature is not electricity or magnetism; it is not identical with any other natural force, for it manifests a series of characteristic effects which differ from all other forms of energy. Therefore I do not hesitate again to designate as 'vital force' this natural agency, not to be identified with any other, whose immediate instrument is the protoplasm, and whose peculiar effects we call life. The atoms and molecules of protoplasm only fulfill the functions which constitute life so long as they are swayed by this vital force." ANTON KERNER, "The Natural History of Plants."

Students who are curious on the subject can consult the "Vitalismus als Geschichte und als Lehre," by Dr. Hans Driesch (Leipzig, 1905); but they will understand it little better afterwards than before. For human history the essential was to convince itself that social energy, though a true energy, was governed by laws of its own.

To the generation of Lord Macaulay and George

Bancroft, the problem seemed scarcely serious. They could ignore the dispute, since Thomson agreed with Tyndall so far as to admit that, for human purposes, the Dissipation of Solar Energy was so slow as to be indistinguishable from Conservation of Energy. The historian never even took the trouble to inform himself of the bearings of the problem. Indeed at that time, the Universities showed a nervous unwillingness to teach philosophy at all, and were especially averse to all philosophies of history, whether inspired by Hegel or by Comte, by Buckle or by Karl Marx. The law that history was not a science, and that society was not an organism, calmed all serious effort; and historians turned to the collection of facts, as the geologists turned to the collection of fossils. For them it was a happy period, and literature profited by it.

In fact, the problem was by no means simple, and the historian might have made himself a very competent professor of Physics without the smallest profit to history. Kelvin's law asserted the constant dissipation of energy, but the process was far more complex than appeared in this statement. Energy had a way of coming and going in phases of intensity much more mysterious than the energy itself. Catastrophe was its law. The sun, according to Tyndall, wasted into space practically all its energy except an imperceptible portion

that happened to fall on the earth; but even this portion was not utilizable, for human purposes, to boil a pint of water, at sea-level, without assistance. Ice, water, and vapor were phases sharply distinct. So the imperceptible portion of solar energy which fell on the earth, reappeared by some mysterious process, to an infinitely minute measure, in the singular form of intensity known as Vital Energy, and disappeared by a sudden and violent change of phase known as death. Man had always flattered himself that he knew —or was about to know—something that would make his own energy intelligible to itself, but he invariably found, on further inquiry, that the more he knew, the less he understood. Vital energy was, perhaps, an intensity;—so, at least, he vaguely hoped;—he knew nothing at all!

No one knew anything; and yet the analogy between Heat and Vital Energy, suggested by Thomson in his Law of Dissipation,—and received by the public with sleepy indifference,—was insisted upon by the physicists in accents that became sharper with every generation, until it began to pass the bounds of scientific restraint. Already in 1884, Faye, in his "Origin of the World," fairly threatened mankind with its doom:—

"We must therefore renounce those brilliant fancies by which we try to deceive ourselves in order to endow

man with unlimited posterity, and to regard the universe as the immense theatre on which is to be developed a spontaneous progress without end. On the contrary, life must disappear, and the grandest material works of the human race will have to be effaced by degrees under the action of a few physical forces which will survive man for a time. Nothing will remain:—'*etiam periere ruinæ!*'"

Thus, it seemed, that whatever the universities thought or taught, the physicists regarded society as an organism in the only respect which seriously concerned historians:—It would die! If life was to disappear, the form of Vital Energy known as Social Energy, must also, presumably, go to increase the Entropy of the Universe, thus proving—at least to the degree necessary and sufficient to produce conviction in historians,—that History was a Science. Although Faye settled this point, as a matter of thermodynamics, as early as 1884, his successors in authority have gone on repeating it with increasing energy of expression ever since. To these outbursts of prophecy the story will have to recur, but for the moment, the only point requiring insistence is that sixty years of progress in science have only intensified the assertion that Vital Energy obeys the law of thermal energy. The sketch of Kelvin's Life and Work by Professor Andrew Gray,—Professor

of Natural Philosophy in the University of Glasgow,—published in 1908, renews the warning in almost angry terms. Once more he asserts, as an axiom of physics, that all work is done by conversion of one energy, or intensity, into another, and a lower:—"If this conversion is prevented, all processes which involve such conversion must cease, and among these are vital processes. . . . It will be the height of imprudence to trust to the prospect, not infrequently referred to, at the present time, of drawing on the energy locked up in the atomic structure of matter. . . . After a large part of the whole existent energy has gone to raise the dead level of things, no difference of temperature, adequate to work between, will be possible, and the inevitable death of all things will approach with headlong rapidity."

This may serve to represent the very last opinion of physicists. The latest expression of metaphysics,—for the present purpose,—shall be taken from the notes added by Eduard von Hartmann to the last edition of his works, dated in 1904:—

"If the social consciousness of to-day rebels so strongly against the thought that vital processes will come to an end in the world, the chief reason is because society has indeed absorbed the first principle of thermodynamics, — the conservation of energy, — but

not the second, the progressive degradation of energy by dissipation and levelling of intensities; and, in consequence, has erroneously interpreted the first law as though it contained an eternal guaranty of the endlessness of vital processes. . . . In reality, the only question is whether, in the actual result, the world-process will work itself out slowly in prodigious lapse of time, according to purely physical laws; or whether it will find its end by means of some metaphysical resource when it has reached its culminating point. Only in the last case would its end coincide with the fulfilment of a purpose or object; in the first case, a long period of purposeless existence would follow after the culmination of life." (Ausgewählte Werke, VIII, pp. 572-573. Leipzig, 1904.)

Thomson's famous paper on "A Universal Tendency in Nature to the Dissipation of Energy" was published in 1852. Seven years afterwards, Charles Darwin announced his law of Evolution, which involved a contradiction,—as von Hartmann implies—to both the laws of thermodynamics. Thomson, physicist and mathematician, had thought only of providing the energy necessary to move his world; Darwin, neither physicist nor mathematician, took the necessary energy as given. Possibly, if he thought about it at all, he assumed the Law of Conservation as the mechanical equivalent of

Lyell's Law of Uniformity; but he seemed scrupulously careful to avoid asserting either principle. On his own account he never committed himself to the doctrine that, within the geological record, organization had largely advanced, or risen to higher powers, but he did assert, and permitted his followers to assert much more broadly that "the inhabitants of the world, at each successive period in its history, have beaten their predecessors in the race for life, and are, in so far, higher in the scale"; meaning probably that they were better fitted to their conditions, but conveying the idea that their vital powers had risen from lower to higher by the spontaneous struggle of the organism for life. This popular understanding of Darwinism had little to do with Darwin, whose great service,—in the field of history,—consisted by no means in his personal theories either of natural selection, or of adaptation, or of uniform evolution; which might be all abandoned without affecting his credit for bringing all vital processes under the law of development or evolution,—whether upward or downward being immaterial to the principle that all history must be studied as a science.

Society naturally and instinctively adopted the view that Evolution must be upward; and Haeckel performed the feat of measuring the height of each step from protozoa up to man; but still without further attempt to

account for the source or the nature of the numerous energies implied in the process of elevation. Apparently he felt no need of invoking any energy beyond that of uniform solar heat, and took for granted the power of all organisms to rise in potential bv its absorption.

Thus, at the same moment, three contradictory laws of energy were in force, all equally useful to science:— 1. The Law of Conservation, that nothing could be added, and nothing lost, in the sum of energy. 2. The Law of Dissipation, that nothing could be added, but that Intensity must always be lost. 3. The Law of Evolution, that Vital Energy could be added, and raised indefinitely in potential, without the smallest apparent compensation.

Although the physicists are far from clear in defining the term Vital Energy, and are exceedingly timid in treating of Social Energy, they are positive that the law of Entropy applies to all vital processes even more rigidly than to mechanical. "Thus it is," says Ostwald ("L'Énergie," Paris, 1910, p. 116), "that animated beings always grow old, and never young." As the point is pivotal for evolution, it must be understood as admitted in the Law of Degradation. One of the latest authorities, M. Dastre, professor of physics at the Sorbonne, in his volume called "La Vie et la Mort" (Paris,

1902), lays down the dogma in one line:—"Vital Energy ends as its last term, in Thermal Energy." He admits that this rule is too absolute; it has exceptions; but the exceptions are not serious:—

"The cycle of energy ends occasionally in mechanical energy (movement), and in some smaller degree, in other energies, as for example, in the electric energy produced by nervous action and the muscles in all animals; or in functions of special organs, as in the rays, torpedoes, and thunder-fish; or finally in the luminous energy of phosphorescent animals; but these are secondary matters." The essential is that the second law of thermodynamics rules biology with an authority fully as despotic as it asserts in physics. "If chemical energy is the generative maternal form of the vital energies, calorific energy is the form of waste (déchet), of excrement; the form which is degraded, according to the expression of the physicists. . . . In the animal organism, heat is transformed into nothing: it is dissipated" (p. 109). "The animal world expends the energy which the vegetable world has accumulated." The vegetable world draws its energy from the sun, and "the animals end by restoring it, in the form of dissipated heat, to the cosmic space."

This teaching is explicit. Animal energies accent and emphasize the law of physics that nature, always and

everywhere, tends to an equilibrium by levelling its intensities. Mechanical energies admit apparent exceptions, like gravitation, but animal energies admit none. All grow old and die. This is the teaching of physics, and although most physicists show caution in defining exactly what they mean by vital energy, the law, as they announce it, is relentless. For human purposes, whatever does work is a form of energy, and since historians exist only to recount and sum up the work that society has done, either as State, or as Church, as civil or as military, as intellectual or physical, organisms, they will, if they obey the physical law, hold that society does work by degrading its energies. On the other hand, if the historian follows Haeckel and the evolutionists, he should hold that vital energy, by raising itself to higher potentials, without apparent compensation, has accomplished its work in defiance of both the laws of thermodynamics.

Down to the end of the nineteenth century nothing greatly mattered, since the actual forces could be fairly well calculated or accounted for on either principle, but schools of applied mechanics are apt to get into trouble by using contradictory methods. One process or the other acquires an advantage. The weaker submits, but in this instance, the difficulty of naming the weaker was extreme. That the Evolutionist should surrender his

conquests seemed quite unlikely, since he felt behind him the whole momentum of popular success and sympathy, and stood as heir-apparent to all the aspirations of mankind. About him were arranged in battalions, like an army, the energies of government, of society, of democracy, of socialism, of nearly all literature and art, as well as hope, and whatever was left of instinct,—all striving to illustrate not the Descent but the Ascent of Man. The *hostis humani generis,* the outlaw and enemy, was the Degradationist, who could have no friends, because he proclaimed the steady and fated enfeeblement and extinction of all nature's energies; but that he should abandon his laws seemed a still more preposterous idea. Never had he asserted them so aggressively, or with such dogmatic authority. He held undisputed possession of every technical school in the world, and even the primary schools were largely under his control. His second law of thermodynamics held its place in every text-book of science. The Universities and higher branches of education were greatly, if not wholly, controlled by his methods. The field of mathematics had become his. He had no serious intellectual rival. Few things are more difficult than to judge how far a society is looking one way and working in another, for the points are shifting and the rate of speed is uncertain. The acceleration of movement seems

rapid, but the inertia, or resistance to deflection, may increase with the rapidity, so that society might pass through phase after phase of speed, like a comet, without noting deflection in its thought. If a simpler figure is needed, society may be likened to an island surrounded by a rising ocean which silently floods its defences. One after another the defences have been abandoned, and society has climbed to higher ground supposed to be out of danger. So the classic Gods were abandoned for monotheism, and scholastic philosophy was dropped in favor of the Newtonian; but the classic Gods and the scholastic philosophy were always popular, and the newer philosophies won their victories by developing compulsory force. Inertia is the law of mind as well as of matter, and inertia is a form of instinct; yet in western civilization it has never held its own.

The pessimism or unpopularity of the law will not prevent its enforcement, if it develops superior force, even if it leads where no one wants to go. The proof is that the law is already enforced in every field excepting that of human history, and even human history has not wholly escaped. In physics it rules with uncontested sway. In physiology, the old army of Evolutionists have suffered defections so serious that no discipline remains. A full account of the situation would need an amount of knowledge that is now granted to

no one; but the most trifling popular science is enough for popular teachers like ourselves.

Every one knows that Darwin owed much of his science as well as of his success to Sir Charles Lyell, who supplied him with the doctrine of uniformity and the evidence to support it. Darwin's own assumptions or theories were quite sufficiently difficult of proof, without adding the doctrine of uniformity; but Sir Charles' ability and authority carried the point in spite of Kelvin's protest that uniformity could not be admitted as possible under the second law of thermodynamics. Lyell's conservative system of evolution, resting on several broad assumptions of fact, became not merely a physiological, but even more a philosophical dogma, and in a literary point of view the Victorian epoch rested largely,—perhaps chiefly,—on the faith that society had but to follow where science led; to—

"Move upward, working out the beast,
And let the ape and tiger die";

in order to attain perfection. An infinite series of imperceptible steps, continuous under uniform conditions since the earliest traces of organic life, and always tending upwards to higher intensities,—tensions,—potentials,—according to the growing complexity of the organism, had already taken the place of religious

dogma, and bridged the gap between two phases of thought.

With a sense of vast relief, the generation which began life in 1850, embraced the new creed, not so much because it was proved, as because it was convenient; but it met with instant difficulties on the side of the Darwinists themselves. The warmest evolutionists were the least confident, not only about adaptation and the struggle for existence, but also, and chiefly, about uniformity. Heer's researches on the arctic flora, already cited by Sir Charles Lyell in the tenth edition of his "Principles" (London, 1867), seemed to upset the law of uniformity from top to bottom and to substitute a sweeping law of catastrophe; so that already in 1879, Saporta, in his History of the World of Plants, asserted that nothing less than absolute revolution in cosmic conditions could account for the changes in northern vegetation. During the whole period since the eocene, the temperature of the planet had steadily declined. "The phenomenon to which the lowering of temperature must be referred," said Saporta, "is in no way peculiar to Europe; it has nothing sudden about it, or accidental, or transient. We pointed out its origin at the end of the eocene; we have marked its progress by its increasing intensity in the polar regions, and by its gradual extension thence towards the south. At the beginning of the oligocene,

the vegetation of the northern temperate zone changes character; new elements, coming from the north, and marking the first progress of a refrigeration, introduce and propagate themselves. We have studied the signs of this revolution, by means of which the differences of latitude tend little by little to accentuate themselves. . . . It is impossible not to admit, when we consider this march which nothing stops, and which continues with moderation and regularity, the influence of a cosmic phenomenon embracing the terrestrial globe altogether" (p. 322). The inference followed:—"We recognize from this point of view as from others, that the world was once young; then adolescent; that it has even passed the age of maturity; man has come late, when a beginning of physical decadence had struck the globe, his domain." ("Le Monde des Plantes," p. 109.)

Nothing could be more fatal, not to Darwin but to Darwin's popular following. As Newton said that he was never a Newtonian, so Darwin might perhaps have said that he was never a Darwinian, but his popular influence lay in the law that evolution had developed itself in unbroken order from lower to higher. Kelvin had indeed, flatly contradicted this assumption of fact, but had done so from the physicist's point of view, as a matter of solar heat and terrestrial cooling; while Saporta's studies of vegetation, to everybody's astonish-

ment, so dramatically confirmed Kelvin's mathematics that, though the two streams of thought continued to flow in opposite directions, Saporta already in 1878 had the courage to incline to the "bold suggestion made some years ago by Dr. Blandet, and approved by the late M. d'Archiac," to the effect that, in times before the cretaceous,—especially well shown in the extravagance of the carboniferous,—the sun equaled the orbit of Mercury in diameter. The long epochs known as the Permian, Triassic, Jurassic, Cretaceous, and Eocene allowed ample time for shrinkage before the Miocene first proved by its temperate vegetation, that the sun had approached its present diameter, and could no longer equably warm the world.

Such an adhesion to the law of thermodynamics, only twenty years after Darwin and Lyell had established their system on the law of Conservation, seemed to strike a very serious blow at the theory of upward evolution as the world understood it. The violent contradiction between Kelvin's Degradation and Darwin's Elevation was so profound,—so flagrant,—so vital to mankind, that the historian of human society must be supposed to have watched with agonized interest the direction which science should take; since the decision of palaeontologists would fatally decide his own. If they should adhere to the high authority of Saporta,

the biologists must follow; and then the historian of man would find himself facing a responsibility such as had never before entered into his imagination.

Thirty years have passed since Saporta published his "Monde des Plantes avant l'Apparition de l'Homme," and a whole generation has indefatigably collected, discussed, published and re-discussed the evidences, with results recorded in a library of books and in a score of great geological museums. With the truths that have been established or the theories that have been proposed, historians need trouble themselves little, or not at all, further than to ask what theories are to-day actually taught or are accepted by standard authorities. For American purposes, the object is best reached by restricting the inquiry to the last ten or fifteen years, and, as far as possible, to the schools of the European continent, because distance makes both teachers and teaching impersonal. Beginning with France, the standard authority in geology is said to be Lapparent's Treatise (3 vols. Paris, 1906), and to this the inquirer turns to ask whether Darwin's ideas, or Kelvin's, have prevailed in the French schools. The answer is easily found:—

"If there is one fact," says Lapparent (Vol. III, p. 1951), "that palaeontology, and especially the branch of that science which concerns the vegetable world, has

put in strong evidence, it is assuredly the progressive diminution of heat in the high latitudes of our globe." Among a number of explanations suggested, none satisfied all the conditions except that of M. Blandet,—the diminution of the apparent diameter of the sun. "Outside of this conception, the maintenance of the solar heat is absolutely inexplicable (p. 1954). . . . One cause alone, according to the laws of thermodynamics, is capable of preserving the solar energy without appealing to the quite inadequate help of outside sources;—this is the phenomenon of condensation in the sun. By the means of such condensation, the calorific power of the sun is able to maintain itself without sensible loss, by means of a lessening of apparent diameter which would need several thousand years to become perceptible to our most delicate apparatus. . . . But if, in our days, the sun, reduced as it is, undergoes still this movement of concentration necessary to maintain its energy, what must have been the difference of its dimensions at other epochs from what they are now? Nothing is more logical than this hypothesis, and since,—while irreproachable from the astronomic point of view,—it is alone adequate to explain the palaeothermal phenomena, we think we cannot do better than propose it for the adhesion of geologists."

Nothing could be more innocent in intention, or at

least in appearance, than this adhesion to the second law of thermodynamics,—this harmonizing of several great branches of science,—this unifying of nature; but its consequences to the old law of Evolution and to the school of Darwin were beyond disguise. Lapparent went on to indicate some of them, and first the necessary abandonment of Lyell's law of uniformity:—

"Let us content ourselves, then, with indicating the possibility of this solution, while affirming, contrary to the doctrines of the uniformitarian school, that the ancient history of our planet has unrolled itself in the midst of external conditions very different from those which now surround us."

While Lapparent offered this theory of solar shrinkage as only a possible solution, other geologists were working on a corollary to the theory, which has become one of the commonest foundations of their teaching. Solar shrinkage might perhaps be suggested as a doubtful possibility, but terrestrial shrinkage, which rests on the same law, seems to be now commonly admitted as a reasonably orthodox dogma. Yet terrestrial shrinkage is a mere derivative, which involves solar shrinkage as its logical and mathematical concomitant. If adopted as a fundamental law of geology, it must be admitted as a fundamental law of solar physics, since the one is as inseparable from the other as a Siamese

twin. Naturally the theory is not conceded to be true; —no theory is;—but it is convenient; it is taught; and the chance is now small that any geological physicist will forego the temptation of using M. Blander's theory as law.

Fortunately for the old school of geologists,—as well as for all schools of historians,—the few certainties of geology as of history are so easily read in opposite senses, that, in practice, every teacher can teach—and ignore—what he pleases. Pure geologists still adhere more or less strictly to the uniformitarian creed and reject the conclusions of Heer and his followers. Geological physicists still teach that if the second law of thermodynamics controlled all history from the gaseous nebula to the glacial epoch, it has certainly controlled the few days or years since the ice-cap retired from the Niagara river. In that case, man became the most advanced type of physical decadence, no longer at the top but at the bottom of the ladder, in face of accelerated extinction.

At what precise moment the sun reached, under this theory, the equilibrium which gave the utmost exuberance to organic life, only a specialist can venture to say; but, from the language of their text-books, a reader gathers that the energy of vegetable growth is supposed to have reached its climax as early as the car-

boniferous,—"période de luxe, s'il en fut jamais" (Sapporta, 73);—and that when this amazing vegeta tion lost its wonderful power, as shown in the coal-formations (Lapparent, II, 1027), it was followed by an equally astonishing animal growth which lasted into the miocene period. There—we are told,—degradation began! At the end of the miocene, both vegetable and animal forms of life are declared to offer proof that the poles could no longer support their previous exuberance. This teaching assumes that the equable temperature, whether high or low, which had prevailed from the poles to the equator, gave place to climatic differences consequent on the sun having shrunk towards its present diameter. Nature instantly showed the shrinkage of energy. "In spite of the multitude of beings which have disappeared at different epochs," says Gaudry ("Essai," 44), "I think that the sum of appearances exceeded that of extinctions down to the end of the miocene period." The steady decline continued until the convulsion of the glacial epoch, when, in the midst of a wrecked solar system, man suddenly appeared. "Since this great event occurred," according to Lapparent (III, 1655), "the organic world has enriched itself with no new species, but several forms have disappeared, among those that surrounded the first men; and the great herbivorous mammals, already on

their decline, have seen their principal representatives, little by little, quit the scene of the world."

This statement, as a mere statement of fact, seems to be accepted as rather unduly mild; but not yet satisfied with admitting that organic geology, like inorganic, confirms the dissipation of energy down to the present day, M. Lapparent, abandoning all hope that the process can ever be reversed, concludes (III, 1961): "If any new term is still to be looked for, it seems as though none could be imagined other than an era where the Soul, freed from the bonds of matter, should dominate. Except for this hope there are none but sombre perspectives in sight for all that surrounds us. The progress of the emersion of boreal lands seems destined to extend from step to step the influence of the polar ice. The sun, whose condensation is already far advanced, will soon find in the narrowing of its diameter no sufficient source for maintaining its heat, and large spots will appear on its surface, destined to transform themselves into a dark shell. The day when the extinction of the central luminary shall be complete, no further physical or physiological reaction can take place on our globe, which will then be reduced to the temperature of space, and the sole light of the stars. But, perhaps, before arriving there, the globe will have lost its oceans and its atmosphere, absorbed in the pores and

fissures of a shell whose thickness will increase from day to day."

If one, and by far the most extensive, period of terrestrial history, is already taught in this sense by physicists, all biology, including human history, will have also to be re-edited by them according to this lugubrious plan; and the University professor of history as it has been hitherto understood, will soon have urgent need to make up his mind whether to accept or resist it. If he decides to accept it, he has only to hold his tongue, and remain quietly in the pleasant meadows of antiquarianism, protected as heretofore by the convenient and sufficient axiom of the nineteenth century that history is not a science, and society not an organism; but if this resource should fail him, his first thought will be to find allies. He will seek them among his Darwinist friends, to begin with; but he will scarcely finish the opening chapter of the last book on Transformation, Mutation, Inheritance, or whatever new name may, as one writer expresses it, dissimulate creative or destructive force under the term Evolution, without discovering that the familiar, genial dispute over the origin of species has turned into a sinister and almost lurid battle over the extinction of species, for which the Darwinian theories of survival are declared inadequate to the point of childishness.

In the place of minute variations extending over indefinite time under uniform conditions, he will find that views have been put prominently forward which bear an alarming resemblance to the second law of thermodynamics. So, one palaeontologist,—Dollo,—formulated in 1893 the law of evolution in three sections, each a contradiction to the old law.—1. Development has proceeded by leaps.—2. It is irreversible.—3. It is limited. Another authority, Rosa, gave new form to an old idea, by showing how variability proceeds according to a law of progressive reduction;—that is to say, every series of forms is destined to extinction according to the degree of its specialization. Even if this law were not rigorously exact, "it is perfectly exact to say that the number and extent of variations diminishes as the specialization advances." The reader, who marks with some nervousness that Man has certainly advanced by leaps, and that his progress seems to be irreversible, seeks at once to know whether he shows signs of reaching its limit; and, for an answer, appeals to the only scientific source of information,—the anthropologist.

Unless the inquirer is full of courage, he will be aghast at the confusion of responses which his prayer disturbs. Yet he knows, if he is an evolutionist, that Darwinians have always had trouble over the origin and end of Man. To Darwin and Haeckel the diffi-

culties were as great as to their successors. The mystery of man was then, and still remains, a scientific scandal which has inevitably roused bad temper, and sometimes bad manners, even in the centres of science itself. Every investigator in turn evaded, with more or less dexterity,—or broke through, with more or less recklessness,—the difficulties that surrounded him; but the difficulties outlived the explanations. The first and most notorious was due to the fact that, while the strict theory of evolution from lower to higher made it reasonable to assume that man was descended from that group of animals which resembled him most, and while there was no doubt that the nearest group which could be supposed to lead up to him was that of the anthropoid ape, the anthropologists instantly found so many scientific objections to this line of ascent that it had to be abandoned from the start. The skull of the young anthropoid, it appeared, had more resemblance than that of its adult parent, to the skull of man; in other words, the anthropoid might be a degraded man, but man could not be a developed anthropoid. The search would have to go much further back, to find some earlier mammal with less resemblance to man, and therefore with fewer evidences of descent, and less probability of satisfying the rules of evidence. Each step in the ascent added enormously to the difficulties of proof.

Every evolutionist knows how disastrously this first failure affected anthropology; nor was the case bettered for the anthropologist by Cope, who, reasoning from the teeth, made man descend from an eocene lemur, and through him from the marsupials, without passing through any known group of anthropoids at all;—a leap backwards covering such vast epochs of unknown time and change,—only to end in a type much lower than that of the despised apes,—as to have no more value for human history than though, instead of a hypothetical lemur, the palaeontologists had offered as an ancestor a hypothetical lingula of archean time.

All this fumbling for an ancestry that should have been self-evident, was sufficiently diconcerting to historians who cared little what kind of a pedigree was given them, but greatly wanted to be sure of it; and who found themselves embarrassed with a primitive man,—or probably a variety of primitive men,—running back without intermediate links to a hypothetical, primitive, eocene lemur, whom no one but a trained palaeontologist could distinguish from a hypothetical, primitive opossum, or weasel or squirrel or any other small form of what is commonly known as vermin. For the historian, the lemur was a grievance. It offered no foundation for any theory, whether of conservation, elevation, or degradation, physical or moral. Even the

Church had always admitted as sound doctrine that God might have used more or less consecutive types for his creations; but between the hypothetic lemur and the talking man, no type, consecutive or other, existed for God to use.

The historian had certainly a right to complain of this Pharaonic command to adopt a lemurian and marsupial ancestry, including the duck-billed platypus, and much more; but had he rashly attempted to seek further, he might probably have found worse. Indeed, from the moment when science had exhausted the whole geological series,—recent, pleistocene, pliocene, miocene, oligocene, and part of the eocene,—without coming upon any reasonable or respectable ancestor at all, the search had become, for the historians, purposes, worse than futile. He would do much better to fall back on the mere hope that his own historical parentage was lost under the polar snows,—like the carboniferous forests,—where some happier anthropoid had been born and bred in temperate miocene luxury, to be driven southward before the ice-cap which obliterated every trace of him and of his polar Eden as he slowly drifted towards the fortieth parallel. Such a vague but aristocratic origin would relieve him from quartering the arms of the lemur, and might help him to suppress the opossum.

Hoping for the best, he next turns to the last textbook,—say Hopf's "Human Species" (London, 1909), —and first notes that it still rests the chief weight of the argument, as Cope did, on the teeth, but in a sense that startles even a sincerely convinced evolutionist. Among the first authorities quoted is Professor Klaatsch of Heidelberg: "As in his opinion, man by no means stands at the head of all living beings with respect to all parts of his organization, so, too, he considers that the human teeth are among the most primitive possessed by any of the existing mammals. Had man not sacrificed twelve teeth in the course of his gradual development, he would now have forty-four, the highest number possessed by any land-dwelling mammal." Assuredly, according to actual standards of physical beauty, a man—and still more a woman—with forty-four teeth would raise scruples about the law of evolution from lower to higher; but the Professor evidently regards the modest number of our actual teeth as a decadence; and goes on to say that even as to his molars, man "has not progressed beyond the stage of development reached by the mammals in the tertiary period." Not a step have the physiologists advanced in thirty years towards proof of any rise in vital energy. Greatly concerned at this evidence of feebleness in the evolution of man from the eocene lemur, the

historian of human society naturally asks what human senses show more development than is proved by the teeth. Hopf makes no pretence of flattery even on this point. "Speaking generally, man, not only in a state of civilization, but also the primitive savage,—the Papuan, for example,—has a much less acute sense of smell than that possessed by animals" (Hopf, 240). Finally, though discouraged, the historian probably inquires in what, then, the evolution of man from lower to higher is believed to consist; and he learns that it consists in the extraordinary development of the brain, with its instruments, the hand, the foot, and the vocal organs; but even the brain is said to show extremely slight real differences from that of the higher monkeys (Vulpian, "Leçons," 1866). "The brain has passed through evolution in all the branches of the tree of mammals; it is highly circumvoluted at the extremity of certain branches; sometimes the richness of its circumvolutions exceeds that of Man" (Topinard, 334); but its only marked development is in weight, and in number of ganglion cells (Hopf, 168).

Inevitably the puzzled historian asks almost stupidly whether the anthropologist holds this increase of brain to prove evolution from lower to higher, and he receives an answer that totally demoralizes him. The weight of the brain is not asserted to be a gauge of its

energy. Neither instinct nor reason is supposed to have any relation to the weight of the brain; on the contrary, "in a list of seventeen brains, the heaviest known, going from 1729 to 2020 grams, there are seven lunatics," and only three men of science, about whose degree of aberration no exact statistics can be reasonably expected (Topinard, 216).

This is only the beginning of anthropological evolution from lower to higher. The anthropologist seems inclined to hold that what is called genius has no relation with weight of brain; but that, even though it had, it would not help evolution, if Arndt is right in asserting that superior mental endowment of any kind is a sign of degeneration; or if Branca is right in thinking it impossible that the progressive enlargement of the human brain can go on indefinitely without enfeebling the body till it dies out; or if Hopf is right (p. 374), in admitting that, in civilized races, increase in intellectual power often goes with a narrowing of the jaw and an early loss of the teeth, and of the hair, and in women with an inability to suckle their children. To complete the picture, the anthropologist who hesitates to say in what sense the brain should be regarded as proving evolution from lower to higher, shows not the least sign of doubt in regard to the degree to which Man is specialized, particularly as shown by his brain, his hand,

his foot, and his vocal organs. In fact, according to Louis Agassiz, a man is "the last term of a series beyond which, following the plan on which the whole animal kingdom is built, no further progress is materially possible" ("De l'Esprit," p. 34), and is, therefore, under Rosa's law of progressive reduction, destined to be rapidly extinguished.

Thus the physical geologist has frankly and finally gone over to the side of Kelvin; the palaeontologist has kept him company, or even went before him; while the anthropologist is somewhat painfully hesitating, obedient to the physicists, but trying to remain true to humanity, though acutely conscious that the two directions cannot be reconciled. For many years M. Topinard has held a sort of position as semi-official anthropologist of France, but he has become incoherent with age, finding himself caught between the irreconcilable contradictions of science and sentiment:—"The end, as far as concerns us, we know," he says in his last volume ("L'Anthropologie," Paris, 1900); "our earth will cease to be habitable; it will grow cold; will lose its atmosphere and its moisture, and will resemble our actual moon. Previously, evolution, from progressive will become stationary, then regressive. Some day, as Huxley suggests, the lichens, the diatomaceae, the protococcus, will perhaps be the only beings adapted to the

conditions;—then, nothing!" The picture seems sad enough, yet M. Topinard might have added that, according to his own palaeontologist authorities, the evolution of life on the earth had ceased to be progressive some millions of years ago, and had passed through its stationary period into regression before man ever appeared; while M. Topinard himself adds (pp. 321, 370) that, "to his stupefaction," he has reached conclusions of his own which seem, to readers who do not take these opinions too seriously, exceedingly like an admission that he finds himself an example of the second law of thermodynamics:—

"Yes; there is contradiction between the animal man,—as he was in a state of nature, and as he has maintained himself to our day,—and the social man such as he ought to be. Yes! the objective realities of science are in contradiction with the subjective aspirations of man. Yes! nature laughs at our conceptions. Society has been born of man, and has been built on sand, often with only materials of convention. The individual for whom it is created is always its worst enemy; he admits it, but will not bend to its necessities."

Although M. Topinard adhered blindly to the second law of thermodynamics in regard to the approaching end of the world, and was logically obliged to accept its conclusion that all useful work or progress, social or

mechanical, depended on inequalities of intensity, endowed with energy still left to dissipate, the moment he realizes that such inequalities still exist, and that therefore progress is still possible, he bewails the fact as an inexplicable and unfortunate mystery. Such cross-purposes have become almost a standard rule in sociology. They have always been the rule in history.

In the earlier scientific commentaries on the Law of Dissipation, astronomers and physicists commonly took some little pains to soften the harshness of their doom by assurances that the prospect was not so black as it seemed, but that the sun would adapt itself to man's convenience by allowing some thousands or millions of years to elapse before its extinction. This pleasing thoughtfulness has vanished. Geologists, when most generous, scarcely allow more than thirty thousand years since the last ice-cap began its partial recession; while, quite commonly, they insist that their most careful and elaborate estimates do not justify them in granting more than a quarter of that time to the very incomplete process of clearing away the ice and snow from the streets of primitive New York and Boston. The cataclysmic ruin that spread over all the most populous parts of the northern hemisphere while the accomplished and highly educated architects of Nippur were laying the arched foundations of their city, has,

it is true, been partially covered or disguised under new vegetation; but even this brief retrospective reprieve is darkened by the earnest assurances of the most popular text-books and teachers that they can hold out no good reason for hoping that the exemption will last. The sun is ready to condense again at any moment, causing another violent disequilibrium, to be followed by another great outburst and waste of its expiring heat.

The humor of these prophecies seldom strikes a reader with its full force in America, but in Europe the love of dramatic effect inspires every line. Compared with the superficial and self-complacent optimism which seems to veneer the surface of society, the frequent and tragic outbursts of physicists, astronomers, geologists, biologists, and sociological socialists announcing the end of the world, surpass all that could be conceived as a natural product of the time. The note of warning verges on the grotesque; it is hysterically solemn; a little more, and it would sound like that of a Salvation army; a small natural shock might easily turn it to a panic. Naturally a historian is most interested in what concerns primitive history, and all the relations of primitive man to nature. He takes up the last work on the subject, which happens in 1910, to be "Les Premières Civilisations," by M. J. de Morgan, published in June, 1909. M. de Morgan is one of the

highest authorities—possibly quite the highest authority—on his subject, and this volume contains the whole result of his vast study. Unconscious of thermodynamics, he treats primitive man as a sort of function of the glacial epoch, and ends by telling his readers (p. 97):—

"The glacial period is far from being ended; our times, which still make an integral part of it, are characterized by an important retreat of the glaciers, started long before the beginnings of history. It is to be supposed that this retreat of the ice is not definitive, but that the cold will return, and with it the depopulation of a part of our globe. Nothing can enable us to foretell the amplitude of this future oscillation, or the lot which the laws of nature destine to humanity. During this cataclysm revolutions will occur which the most fecund imagination cannot conceive,—disasters the more horrible because, while the population of the earth goes on increasing every day, and even the less favored districts little by little become inhabited, the different human groups, crowded back one on another, and finding no more space for existence, will be driven to internecine destruction."

M. de Morgan belongs to the most serious class of historians, while M. Camille Flammarion, the distinguished director of the Meudon observatory, besides

being a serious astronomer, is also one of the most widely read, and most highly intelligent, vulgarizers of science. When he reaches the point of describing the solar catastrophe in his popular astronomy, he lays bare an enormous field for harrowing horrors ("Astronomie Populaire," 102, 103, Paris, 1905):—

"Life and human activity will insensibly be shut up within the tropical zones, Saint Petersburg, Berlin, London, Paris, Vienna, Constantinople, Rome, will successively sink to sleep under their eternal cerements. During many centuries, equatorial humanity will undertake vain arctic expeditions to rediscover under the ice the sites of Paris, of Bordeaux, of Lyons, of Marseilles. The sea-shores will have changed and the map of the earth will be transformed. No longer will man live,—no longer will he breathe,—except in the equatorial zone, down to the day when the last tribe, already expiring in cold and hunger, shall camp on the shores of the last sea in the rays of a pale sun which will henceforward illumine an earth that is only a wandering tomb, turning around a useless light and a barren heat. Surprised by the cold, the last human family has been touched by the finger of death, and soon their bones will be buried under the shroud of eternal ice. The historian of nature would then be able to write:—'Here lies the entire humanity of a world which has

lived! Here lie all the dreams of ambition, all the conquests of military glory, all the resounding affairs of finance, all the systems of an imperfect science, and also all the oaths of mortals' love! Here lie all the beauties of earth!'—But no mortuary stone will mark the spot where the poor planet shall have rendered its last sigh!"

As though to assure the public that he knows what he is talking about, M. Flammarion, who is a practical astronomer, goes on with a certain sombre exaltation, like a religious prophet, to say that the terrors he predicts are of common occurrence in astronomy, and leaves his scholars to infer that nature regards her end as attained only when she has treated man as an enemy to be crushed:—

"Already we have seen twenty-five stars sparkle with a spasmodic light in the heavens, and fall back in extinction neighboring death! Already some of the brilliant stars hailed by our fathers have disappeared from the charts of the sky, and a great number of red stars have entered into their period of extinction!"

Volumes would be needed if a writer should attempt to follow the track of this idea through all the branches of present thought; but, without unnecessarily disturbing the labors of anthropology and biology, the merest insect might be excused for asking what happens to

fellow insects, who, like himself, are enjoying the precarious hospitality of these numerous solar systems. M. de Morgan and M. Flammarion are contented with freezing them; but M. Lapparent takes the loftier view that they will do better to become disembodied spirits; which is even less likely to suit either the American professor or the American student, whose ideas of education are exceptionally practical. The "soul, freed from the bonds of matter," seems to require no education unless in the passive consciousness of pure mathematics and logic, which has hitherto been the weakest side of the American student, who is averse even to the ingenuous simplicity of logarithms and vectors. More than this, the law of degradation inexorably implies that, throughout the whole series of phases which may intervene in the future as in the past, in the dissipation of the higher intensities, a sympathetic exhaustion must be expected in all the energies dependent on the central system, among which, as the palaeontologists and physicists have assured us, the vital energies are not only the most dependent, but also and particularly the most sensitive. Physical or mental, they should, according to theory, suffer an accelerated decline, and yet their actual position should also show a certain lag behind the rate of the central energy. They are really worse off than they seem. The soothing vision of

thousands or millions of years, for the ultimate extinction of solar energy, protects the Universities to a highly inadequate degree from their own extinction in the process. All energies which are convertible into heat must suffer degradation; among these, as the physicists expressly insist, are all vital processes; the mere temporary approach to a final equilibrium would be fatal; and, among all the infinite possibilities of evolution, the only absolute certainty in physics is that the earth every day approaches it. No one can be trusted to express so much as an opinion about the moment when any special vital process may expect to be reduced in energy; man and beast can, at the best, look forward only to a diversified agony of twenty million years; but at no instant of this considerable period can the professor of mathematics flatter either himself or his students with an exclusive or extended hope of escaping imbecility.

According to some geologists, this view is extravagantly—almost ridiculously—optimistic; but with the scientific correctness of these opinions, the historian is not concerned. He asks only how far the teaching of his colleagues contradicts his own, and how far society sides with his contradictors. His question is difficult to answer. At first sight he is conscious of no divergence. Society has the air of taking for granted its

indefinite progress towards perfection with more confidence, and sometimes with more dogmatism than in 1830, when Macaulay made it a literary law by his famous polemic against Southey. Yet the same society has acquired a growing habit of feeling its own pulse, and registering its own temperature, from day to day; of prescribing to itself new régimes from year to year; and of doubting its own health like a nervous invalid. Granting that the intended effect of intellectual education is,—as Bacon, Descartes, and Kant began by insisting,—a habit of doubt, it is only in a very secondary sense a habit of timidity or despair. To a certain point, the more education, the more hesitation; but beyond that point, confidence should begin. Keeping Europe still in view for illustration and assuming for the moment that America does not exist, every reader of the French or German papers knows that not a day passes without producing some uneasy discussion of supposed social decreptitude;—falling off of the birthrate;—decline of rural population;—lowering of army standards;—multiplication of suicides;—increase of insanity or idiocy,—of cancer,—of tuberculosis;—signs of nervous exhaustion,—of enfeebled vitality,—"habits" of alcoholism and drugs,—failure of eye-sight in the young,—and so on, without end, coupled with suggestions for correcting these evils such as remind a historian

of the Lex Poppaea and the Roman Empire rather than they prove that careless confidence in itself which ought to stamp the rapid rise of social energy which every one asserts and admits. A great newspaper opens the discussion of a social reform by the axiom that "there are unmistakable signs of deterioration in the race." The County Council of London publishes a yearly volume of elaborate statistics, only to prove, according to the London *Times,* that "the great city of to-day," of which Berlin is the most significant type, "exhibits a constantly diminishing vitality"; and, in almost the same breath, other journals exult in showing that the globe is rapidly becoming a suburb of the great cities. Rarely does the press dwell on proofs of social evolution except as shown negatively in decline of the death-rate, or of illiteracy, or in relief from pain, and never does the statistician or sociologist help the historian to any clear understanding of the progress expected as his literary goal. The medical profession is singularly shy of pledges. The poets are pessimists to a man—and to a woman. The legislators pass half their time, in Germany, France, and England, framing social legislation, of which a large part rests on the right and duty of society to protect itself against itself, not under the fiction of elevating itself from lower to higher, but—as in the case of alcohol and drugs—to protect itself from

deterioration by the exercise of powers analogous to the power of war.

According to the sociologists, the most serious symptom of all is the extension of philosophical schools founded on the supposed failure of society:—"The formation of these great systems is the sign that the pessimist current has reached an abnormal degree of intensity due to some perturbation of the social organism. Now we all know how they have multiplied in our day. To get a just idea of their number and their importance, we have to consider not merely the philosophies which officially profess that character, like those of Schopenhauer, von Hartmann, etc., but we must also take account of all those which, under different names, are the results of the same spirit. The anarchist, the esthete, the mystic, the revolutionary socialist, even if they do not despair of the future, agree with the pessimist in the same sentiment of hatred and disgust for whatever is; in the same need of destroying the real, and escaping from it. The collective melancholy would not have invaded consciousness to that point unless it has taken morbid development; and in consequence the development of suicide which results from it, is of the same nature. All the proofs unite in causing us to regard the enormous increase which has shown itself within a century in the number of

voluntary deaths, as a pathological phenomenon which becomes every day more menacing."—EMILE DURKHEIM, "Le Suicide." Paris, 1897.

As yet the press is alarmist with decency, even in Paris and Berlin, but at the rate of progress since 1870, the press might soon learn to blacken the prospects of humanity with all the picturesque genius of Camille Flammarion. A little more superficial knowledge is all it needs; the general disposition is already excellent. Meanwhile, the teacher of history has fallen out of sight. The freedom that was liberally extended to others was denied to him. Supposing Kelvin's law, with Lapparent's conclusions, and Flammarion's illustrations, to be rigorously true, and that its truth was admitted in biology as in physics, the American professor who should begin his annual course by announcing to his class that their year's work would be devoted to showing in American history "a universal tendency to the dissipation of energy" and degradation of thought, which would soon end in making America "improper for the habitation of man as he is now constituted," might not fear the fate of Giordano Bruno, but would certainly expect that of Galileo, even though he knew that every member of the Cardinals' College of professors held the same opinion. The University would have to protect itself by dismissing him.

The truth or the error of the three Laws of Evolution does not properly concern the teacher. No physicist can, in these days, be expected to take oath that Dalton's atoms, or Willard Gibbs' phases, or Bernouilli's kinetic gases, are true. He uses for his scholars the figure or the formula which best suits their convenience. The historian or sociologist is alone restricted in the use of formulas which shock the moral sense; yet the stoppage of discussion in the historical lecture-room cannot affect the teaching of the same young men in the physical laboratory,—still less the legislation of their parents at the State capital; it would merely ruin the school of history. However much to be regretted is such a result, society cannot safely permit itself to be condemned to a lingering death, which is sure to tend towards suicide, merely to suit the convenience of school-teachers. The dilemma is real; it may become serious; in any case it needs to be understood.

The battle of Evolution has never been wholly won; the chances at this moment favor the fear that it may yet be wholly lost. The Darwinist no longer talks of Evolution; he uses the word Transformation. The historian of human society has hitherto, as a habit, preferred to write or to lecture on a tacit assumption that humanity showed upward progress, even when it

emphatically showed the contrary, as was not uncommon; but this passive attitude cannot be held against the physicist who invades his territory and takes the teaching of history out of his hands. Somewhere he will have to make a stand, but he has been already so much weakened by the surrender of his defences that he knows no longer where a stand can be made. As a form of Vital Energy he is convicted of being a Vertebrate, a Mammal, a Monodelphe, a Primate, and must eternally, by his body, be subject to the second law of thermodynamics. Escape there is impossible. Science has shut and barred every known exit. Man can detect no outlet except through the loophole called Mind, and even to avail himself of this, he must follow Lapparent's advice,—become a disembodied spirit and seek a confederate among such physicists or physiologists as are willing to admit that man, as an animal, has no importance; that his evolution or degradation as an organism is immaterial; that his physical force or condition has nothing to do with the subject; that the old ascetics were correct in suppressing the body; and that his consciousness is sufficient proof of his right to regard Reason as the highest potential of Vital Energy.

The historian, thrown back on this oldest of battlegrounds, may console himself with the thought that the

physicists and physiologists are as much embarrassed as himself; but while, in former ages, the world went on, after a fashion, trusting to the energy of its archaic instincts to make good the lapses of its reasoning powers, the external pressure of physical forces, under their thermodynamic laws, seems of late to have literally driven physical science into an assumption of universal authority, so that physiologists can no longer evade the logical necessity of framing a stem-history for the mind, as for the body or the skeleton; and since their law tends strongly towards monism,—unity of energy,—they cannot supply man with any other energies or laws than he inherited from his only known—or unknown—ancestor, the hypothetical eocene lemur. In the system of *Energetik,* Reason can be only another phase of the energy earlier known as Instinct or Intuition; and if this be admitted as the stem-history of the Mind as far back as the eocene lemur, it must be admitted for all forms of Vital Energy back to the vegetables and perhaps even to the crystals. In the absence of any definite break in the series, all must be treated as endowed with energy equivalent to will.

The idea is very familiar in philosophy; the strangeness consists in its gaining foothold in science. At the Congress of the Italian Society for the Progress of Sciences held at Parma in 1907, Ciamician, the dis-

tinguished Professor of the University of Bologna, suggested that the potential of Vital Energy should be taken as the Will. The step seems logical, and to the historian it seems natural. The idea is as old as Aristotle; any one who cares to study its history will find it in Eduard von Hartmann's "Philosophie des Unbewussten" (Vol. II, pp. 426-439, Leipzig, 1904); but, for the actual uses of to-day, the story goes back no further than to Schopenhauer's famous work, "Die Welt als Wille," which appeared in 1819-1844. Schopenhauer held that all energy in nature, latent, or active, is identical with Will. Before his time,—he claimed,—the concept of Will was included in the concept of Force; he reversed the order on the ground that the unknown should be referred to the known, and that therefore the whole universe of energy, known or unknown, of whatever intensity or volume, should be brought into the category of intuition. The philosophers, even when rejecting the identity of Will with Energy, were before long busily coquetting with the idea, which offered extraordinary charms to inventors of systems. For the historian, Schopenhauer's method had the double merit of logically merging the two great historical schools of thought. The old idea of Form, which ruled the philosophy of Aristotle and Thomas Aquinas, slipped readily over the idea of

Energy, taught by Kelvin and Clausius, so that henceforward it mattered little whether the schools, in their rage for nomenclature, called the result "Will," or "Entelechy," or "Dominant," or "Organic Principle" or "Trieb," or "Strebung," or "Intuition," or "Instinct," or just simply "Force" as of old; even the forbidden words "Creative power" became almost orthodox science; in any case the logic of "Will" or "Energetik" imperatively required that every conception whatever, involving a potential, obliged ontologists to regard the will-power of every stem as the source of variation in the branches, and to admit, as a physical necessity, that the branch which has lost the power of variation should be regarded as an example of enfeebled energy falling under the second law of thermodynamics.

Such an arrangement, however convenient for degradationists, and however tempting to students of palaeontology in particular, is likely to bring trouble on other branches of education. Especially for human history its bearings are painfully pointed. Already the anthropologists have admitted man to be specialized beyond the hope of further variation, so that, as an energy, he must be treated as a weakened Will—an enfeebled vitality—a degraded potential. He cannot himself deny that his highest Will-power, whether individual or social, must have proved itself by his

highest variation, which was incontrovertibly his act of transforming himself from a hypothetical eocene lemur, —whatever such a creature may have been,—into a man speaking an elaborately inflected language. This staggering but self-evident certainty requires many phases of weakening Will-power to intervene in the process of subsidence into the reflective, hesitating, relatively passage stage called Reason; so that in the end, if the biologists insist on imposing their law on the anthropologists, while at the same time refusing to admit a break in the series, the historian will have to define his profession as the science of human degradation. The law of thermodynamics must embrace human history in its last as well as in its earliest phase. If the physicist can suggest any plausible way of escaping this demonstration, either logically or by mathematics, he will confer a great benefit on history; but, pending his decision, if the highest Will-power is conceded to have existed first, and if the physicist is to be granted his postulate that height and intensity are equivalent terms, while fall and diffusion are equivalent to degradation, then the intenser energy of Will which showed itself in the primitive extravagance of variation for which Darwin tried so painfully to account by uniformitarian formulas, must have been—and must be now in the constant process of being—degraded and lost, and can

never be recovered. The process, in physics, is not reversible.

If the historian of human society is to let himself be placed in this position, the fact should be understood and accepted in advance. In that case, two schools of history can be easily organized; but the effect on other branches of instruction is not so simple. Ciamician's suggestion,—like Schopenhauer's, like Nietzsche's, like Eduard von Hartmann's philosophy,—does, no doubt, threaten human history with fantastic revolution, but perhaps its strangest result is that of converting metaphysics into a branch of physics. Nothing in the history of philosophy is more distinctly marked than the effort of physics and metaphysics, since 1890, to approach each other. Only a specialist knows even the titles of the books on this subject, in the German language alone; but a beginner might perhaps try to get an idea of the process from Wilhelm Wundt's well-known "System der Philosophie" (Leipzig, 1897). The naturalist now readily admits that plants have souls—or will-power,—but he appropriates the soul as an energy of thermodynamics. At first sight, the tendency seems towards metaphysics, but the true current is the reverse. The chaos is more chaotic than ever, but the effort to make the laws of *Energetik* cover all, is perhaps the only very vigorous intellectual activity now in evidence.

Both parties have in consequence appealed to the Psychologists, and, under the lead of Ostwald in Germany and of Loeb in America, have created, within the last few years, a new literature so extensive as to defy all students except advanced specialists. Indeed, almost as in mathematics, the specialist himself is rarely equal to his task. Every country in the world is contributing to the pursuit of psychological laws. In Russia, Krainsky's volume on the "Law of Conservation of Energy applied to Psychical Activity" appeared as long ago as the year 1897. The amount of intelligence and patient research put into the investigation is as great as though wealth were its end; and, though the drift of evidence may seem to a historian both clear and strong, he has, as yet, no right to hamper the inquiry by inflicting on these exceedingly clever and earnest seekers any inquiries of his own. At most, in his desperate search for allies to protect him from the tyranny of thermodynamics, he might timidly ask, not them but himself, whether the new psychology tends towards the possibility that Reason may be a more or less remote consequence of Tropism,—that is to say, a form of motion excited by exterior forces. In itself, this old and very familiar theory, that "nous vivons parce que nous sommes excités," is as indifferent to sociologists as any other physico-chemical or mechanical analogy used for pur-

poses of technical instruction; but if it goes to the point of asserting, as an acquired truth, that the motion of the mind is an induced motion which follows the laws of electricity, the historian of mind in its social variety will find himself seriously embarrassed. Without going back to the earlier discussion of this burning question, an inquirer may allow himself to quote the latest form in which the distinguished chief of the school states it. Ostwald says:—"Between psychological and mechanical operations, there seems to be nearly the same difference and the same resemblance, as between electric and chemical operations" ("L'Énergie." Paris, 1910, p. 210). On this question, Loeb is even a higher authority than Ostwald, and his latest expressions are still more emphatic. He recognizes no such thing as Will:—"It seems to me," he says, "that it is in the interest of psychology itself to favor the development of the theory of tropisms"; and not of tropisms alone; —"My object is to refer psychical phenomena not only to tropisms but also to physico-chemical phenomena" ("La Revue des Idées," October 15, 1909). With the utmost ingenuity and labour he has proved that, at least in many low organisms, what is taken for Will is really mechanical attraction.

Loeb's demonstrations are quite beautiful pieces of work which rouse high admiration for his powers; but

their bearing on his colleagues is obscure. If Thought is capable of being classed with Electricity, or Will with chemical affinity, as a mode of motion, it seems necessarily to fall at once under the second law of thermodynamics as one of the energies which most easily degrades itself, and, if not carefully guarded, returns bodily to the cheaper form called Heat. Of all possible theories, this is likely to prove the most fatal to Professors of History.

The dilemma is pointed out by Dr. Hanna Thomson, in his book on the Brain, with the emphasis that suits its tension:—"Physically the gap between the brain of man and the brain of an anthropoid ape is too insignificant to count; but their difference as beings corresponds to the distance of the earth from the nearest fixed star. The brain of man does not account for man? What does?"

The question, thus bluntly posed, is bluntly answered in a sense hostile to the physicist law. The brain is developed by the Will, which lies within and behind the brain:—"By practice . . . the Will-stimulus will not only organize brain-centres to perform new functions, but will project new connecting,—or, as they are technically called, association—fibres, which will make nerve-centres work together as they could not, without being thus associated." The motive-power is not of the

brain, "because it is the masterful personal Will which makes the brain human" by developing one of the brain-hemispheres; and "this Something known as Will" continues Dr. Hanna Thomson, "is not natural, but supernatural, both in its powers and in its creations."

Of course the supernatural character of the Will is the whole point in dispute, and the usual doctrine of the modern psychologist substitutes the word Nature for the word Supernatural. Thus Paul Flechsig, concluding his address to the Psychological Congress in Rome (1905), says that "only by constant, progressive changes in the physical form of the brain, has Nature succeeded in attaining this truly lofty end. Thus the Will shows organic evolution from first to last, and shows in this respect no difference from other bodily functions. It is a product of organic nature, and, at least in its broadest sense, bears that stamp."

The three views seem far apart, and yet one can conceive that Kelvin, who troubled himself only with the practical means of obtaining a fall of potential equivalent to the work done, might have seen no necessary contradiction to his law in either case:—

"Quite so!" he might be supposed to reply; "the force that Thomson calls supernatural Will, and Flechsig calls an organic function, and Loeb calls a physico-chemical relation, is the force which I call vital

Energy, and which I agree with Dr. Thomson in regarding as supernatural in the sense that nature no longer produces it here, more than she produces any other element or atom. Physicists are at perfect liberty to regard the Will as another name for the same primitive, elementary, unexplained energy which gave odor to a molecule of copper, or made the magnolia burst into flower with more than animal sensuality and perfection of form, color, scent, and line; or the caterpillar suddenly soar into the air with the amazing, inconceivable sensual properties of the butterfly; but the mere brain-mechanism you talk about is, in physics, far less extraordinary, as Will, than what went before it,—creations always growing higher in tension as you go backward,—like the eye, or the innumerable varieties or transformations of the shapes which vital energy has taken in every province of the vegetable and animal kingdoms, while all are still subordinate and even trivial when compared with the primary creation of energy itself, about which no one knows anything except its name,—Nature."

The professor of physics will be shocked at seeing such words put into Kelvin's mouth. In that case Kelvin's own words will answer almost equally well: "Science positively affirms creative power. . . . Modern biologists are coming once more to a firm acceptance

of something beyond mere gravitational, chemical, and physical forces; and that unknown thing is a vital principle. . . . We are absolutely forced by science to admit and to believe with absolute confidence in a directive power. . . . There is nothing between absolute scientific belief in creative power, and the acceptance of the theory of a fortuitous concourse of atoms. Just think of a number of atoms falling together of their own accord, and making a crystal, a sprig of moss, a microbe, a living animal!" (Life, 1098.)

Such reasoning in circles helps the historian little to make headway against the current of physical energies. His dilemma remains untouched. The physicist says that Thought is an organic growth which has the faculty of determining its own action within certain limits, but whose "Freedom" exists only in the atmosphere of ideals. By the majority of physiologists, Thought seems to be regarded—at present—as a more or less degraded Act,—an enfeebled function of Will:—

"Thought comes as the result of helplessness," says Lalande in his volume on "Dissolution" (Paris, 1899. p. 166); "Thought, as Bain says, is the refraining from speech or action. The truth is, therefore, that action comes first; the idea is an act which tends to accomplish itself, and which, when stopped by some obstacle before its realization, finds a new form of reality in that stop-

page. Jean Jacques Rousseau said: 'The man who thinks is a depraved animal'; and in this he expressed an exact view of psychology. As far as he is animal, the thinker is a bad animal; eating badly; digesting badly; often dying without posterity. In him the degradation of vital energy is flagrant. (La dépravation de la nature physique est visible chez lui.)"

The late volume of M. Bergson, "L'Evolution Créatrice," is the most widely known among the very latest efforts of metaphysicians to defend their conceptions against the methods of physics; and yet, on this point of Reason and Instinct, M. Bergson seems ready to go further than M. Lalande. The whole chapter on Instinct ought to be read, and studied in connection with the treatment of the same subject by Reinke, in his "Einleitung" (Kap. 21), and the source of it all in Eduard von Hartmann's "Unbewusste"; but a few paragraphs will serve to express the present views of the Collège de France about the relative value of phases of life as forces:—

"From our point of view, life appears globally as an immense wave which starts from a centre to propagate itself outwards, and which is arrested at almost every point of its circumference, and is converted into oscillation without advance; at one point alone, it has forced the obstacle, and the impulse has passed on freely. This

liberty is registered in the form of man. Everywhere except with man, consciousness has been brought to a stop; with man alone it has pursued its road. . . . In doing so, it is true, it has abandoned not merely the baggage that embarrassed it, but has been obliged to renounce also some precious properties. Consciousness, in man, is chiefly intelligence. It might have been,—it seems as though it ought to have been,—intuition too. . . . Another evolution might have led to a humanity either still more intelligent, or more intuitive. In reality, in the humanity of which we make part, intuition is almost completely sacrificed to intelligence. . . . Intuition is still there, but vague, and especially discontinuous. It is a lamp, almost extinguished, which gains strength at long intervals, where a vital interest is at hazard, but only for a few instants. On our personality, on our liberty, on the place we occupy in nature as a whole, on our origin, and perhaps also on our destiny it casts a feeble and flickering light, but a light which pierces, none the less, the darkness of the night in which our intelligence leaves us" (pp. 288-289).

If this is the best that physiology and metaphysics can do to help the historian of man, the outlook is far from cheerful. The historian is required either expressly to assert, or surreptitiously to assume, before his students,

that the whole function of nature has been the ultimate production of this one-sided Consciousness,—this amputated Intelligence,—this degraded Act,—this truncated Will. As the function of the crystal is to produce the order of its cleavage, and that of the rose, the beauty of its flower, and that of the peacock, the splendors of its tail, and as, except for these purposes, neither crystal, rose nor peacock has as much human interest as a thistle or a maggot, so the function of man is, to the historian, the production of Thought; but if all the other sciences affirm that not Thought but Instinct is the potential of Vital Energy, and if the beauties of Thought—shown in the intuitions of artistic genius,—are to be taken for the last traces of an instinct now wholly dead or dying, nothing remains for the historian to describe or develop except the history of a more or less mechanical dissolution. The mere act of reproduction, which seems to have been the most absorbing and passionate purpose of primitive instinct, concerns history not at all, except as the botanist is concerned with the question whether the flower is a developed or degraded leaf; but the question whether the plant exists to produce the flower, or to produce the leaf, is vital. The University, as distinct from the technological school, has no proper function other than to teach that the flower of vital energy is Thought, and that not Instinct but Intellect is the

highest power of a supernatural Will;—an ultimate, independent, self-producing, self-sustaining, incorruptible solvent of all earlier or lower energies, and incapable of degradation or dissolution.

Intellect should bear the same relation to Instinct that the sun bears to a gaseous nebula, and hitherto in human history it has asserted this relation without a doubt of its self-evident truth. The assertion has led to physical violence and intellectual extravagance without limit, so that history shows man as alternately insane with his own pride of intellect, and shuddering with horror at its bloody consequences; but the remains of primitive instinct taught society that it could not abandon its claim to be, or to represent, a supernatural and independent energy, without, by the same act, admitting and demonstrating its progressive enfeeblement of will. If Intellect led to such an abdication, it proved the universal truth of the second thermodynamic law.

From the beginnings of philosophy and religion, the thinker was taught by the mere act of thinking, to take for granted that his mind was the highest energy of nature. Society still believes it, and asserts its supremacy, on no other ground, with a sustained force which is the chief theme of history, and which showed no sign of relaxation until attacked in the eighteenth century in its theological or supernatural outposts. Society

must still continue to act upon it, as the Platonist, the Stoic and the Christian did, for the obvious reason that it was and is their only motive for existence,—their solitary title to their identity.

History has never regarded itself as a science of statistics. It was the Science of Vital Energy in relation with time; and of late this radiating centre of its life has been steadily tending,—together with every form of physical and mechanical energy,—towards mathematical expression. The torrent of physical energy has swept society into its course, until every school, and almost every teacher in the world,—except perhaps in the Church,—takes an attitude of instinctive and silent hostility to any form of energy that claims to be independent. Even though the triumph of this teaching is the ultimate degradation of the energy that is taught, —of the teacher as well as of the pupil and the universe,—and the more complete his victory, the more rapid his degradation, the fault is not his that the radiating centre of his world should betray this visible decline of vigor.

Very unwillingly can he admit Reason to be an energy at all; at the utmost, he can hardly allow it to be more than a passive instrument of a physico-chemical energy called Will;—an ingenious economy in the application of power; a catalytic medium; a dynamo,

mysteriously converting one form of energy into a lower;—but if persuaded to concede the intrinsic force of Reason, he must still reject its independence. As a force it must obey the laws of force; as an energy it must content itself with such freedom as the laws of energy allow; and in any case it must submit to the final and fundamental necessity of Degradation.

The same law, by still stronger reasoning, applies to the Will itself.

THE SOLUTIONS

CHAPTER II

The Solutions

THE general reader, though apt to mistake the drift of thought, is still rather a better judge of it than the specialist can be, and he gets, from the literature of the twentieth century in its first decade, a decided impression that educational energy has passed into the hands of the physico-chemists and teachers of *Energetik* or thermodynamics. The old Law of Conservation, or mechanics, still rules in the workshop, but is somewhat lifeless in the scholars if not in the schools. Its teachers seem rather inactive, or even indifferent; yet possibly, here and there, one of them may feel uneasy at the prospect of actually coming to blows with his brother-professors as in the old days of religion. The Law of Conservation was an easy one; it left a reasonable share of freedom in the universe; even astronomers were allowed to be devout, and sometimes actually were so; while in strictness, physicists cease to be physicists unless they hold that the law of Entropy includes Gods and men as well as universes. Nevertheless even a

physicist may occasionally bear in patience with perfectly impartial, and, though conservative, yet not unsympathetic bystanders, who try to act as though the door were still open, and who beg only to be told what the new physicists are willing to do for mankind. What mankind will do for itself is quite another matter, since probably all teachers admit that, in daily life, society may go on indefinitely, quite as well,—or as ill,—in the future as in the past; but as between schools of education the divergence is wide. Possibly the Universities may think it safer to ignore the dilemma for another decade or two, as they have ignored so many others; but they would do better to reach an understanding if they can, especially because, if both parties could be brought into some slight sacrifice of principle, and so abate the rigor of their law, the compromise might put new life into the school of history, which badly needs it.

For purposes of teaching, the figure is alone essential, and the figure of Rise and Fall has done infinite harm from the beginnings of thought. That of Expansion and Contraction is far more scientific, even in history. Evolution, again, is troublesome, and has already yielded to the less compromising figure of Transformation. Expansion and Transformation are words which commit teachers to no inconvenient dogma; indeed, they are so happily adapted for Galileos who are wise

enough not to shock opinion, that they seem to impose themselves on the lecture-room. In strictness, no doubt, water which falls and dynamite which expands, are equally degraded energies, but the mind is repelled by the idea of degradation, while it is pleased by the figure of expansion. Because an energy diffused like table-salt in water, it is not rendered less useful; on the contrary, it can only by that process be made useful at all to an animal like man whose life is shut within narrow limits of intensity; who sends for a physician if his temperature rises a single degree, and who dies if it rises or falls 5° Centigrade; whose bath must be tempered and his alcohol diluted; and whose highest ambition is to train and temper his own brute energies to obey law. Notoriously civilization and education enfeeble personal energy; *emollit mores:* they aim especially at extending the forces of society at cost of the intensity of individual forces. "Thou shalt not," is the beginning of law. The individual, like the crystal of salt, is absorbed in the solution, but the solution does work which the individual could not do.

Put in this form the law of thermodynamics seems less obnoxious. With the change of one word to another, the most sensitive evolutionist might not refuse a hearing to the physicist who should affirm that organic as well as inorganic nature shows a universal

tendency to the dissipation of energy. At the utmost, the Evolutionist would need only to point out that nature, contrary to her usually wasteful habits, often teaches extreme economy, as when she locks up her energies in atoms and molecules, or, what is more to man's purpose, when she trains the glow-worm to habits of costless industry that may well make the sun veil its face; but, consenting to pass over, for the moment, this restriction on thermodynamic extravagance, the Darwinian will perhaps for the sake of harmony, concede that, however economical the process may be in its details, dissipation of energy is always occurring in the mass, and that nature shows no known machinery for restoring the energy which she dissipates. If the physiologists insist on this concession, the Darwinian may perhaps, by way of reaching an issue, content himself with allowing it, with only a single, but serious, restriction.

This single restriction concerns the limitations of science itself, which has thus far penetrated only the grosser operations of nature, and cannot deny that further knowledge may—and probably will—overthrow much of the experience of physics. This possibility is constantly discussed by the most eminent physicists, and is open to endless discussion by physiologists; but since it is the last ground on which the Darwinian can

make a stand, he will do well to reserve it, on the chance that new scientific horizons will open to him.

Supposing, then, that the physicist takes the lead, and seeks for a means of compromise,—some middle term, on which the elevationist can stand while discussing the details of a treaty! The degradationist can produce from his stores of energy a number of figures for choice—such as that of water, which expands or contracts, according to the temperature, or falls according to its position; or electricity, which dissipates itself in work; or of dynamite, which does work by explosion; or of gases, which work restlessly without accomplishing anything; or of table-salt, which dissolves mysteriously in water, to help digestion or stimulate appetite; but possibly he may begin with his favorite figure of a gaseous nebula, and may offer to treat primitive humanity as a volume of human molecules of unequal intensities, tending to dissipate energy, and to correct the loss by concentrating mankind into a single, dense mass like the sun. History would then become a record of successive phases of contraction, divided by periods of explosion, tending always towards an ultimate equilibrium in the form of a volume of human molecules of equal intensity, without coördination.

If this analogy, with its law of phases, should be rejected, the physicist might still offer a number of

others, likening social energy to light, heat, electricity, or radiating matter;—in short to any form of physical energy, provided it obeyed his second law of thermodynamics, by dissipating itself beyond recovery; but, with the utmost good-will, the evolutionist will find himself much embarrassed to accept any of these offers. If he is to remain evolutionist,—and he has no other motive for existence,—he is forced to assert, as his most modest claim, the concession of two points:—1. That organic life has the exclusive power of ecomonizing nature's waste.—2. That man alone enjoys the supernatural power consciously reversing nature's process, by raising her dissipated energies, including his own, to higher intensities. That is to say, man must possess the exclusive power of reversing the process of extinction inherent in other activities of nature. The mere conservation of energy would not be enough for him, whatever it is for the glow-worm.

The physicist cannot for a moment be expected to grant either of these demands, and is quite likely to be irritated by them even to the point of flatly denying any exclusive privileges to organic life except in its processes. He is capable of going on to question the value of the processes too, especially on the point of economy, and of asserting that organisms are bad economists compared with inorganic matter. He will readily

admit that some of the lower forms of life are economists:—the honey-bee, for example; and some caterpillars which store silk, and the coral polyp which stores lime, and so forth; but the vegetables do much better, with their starch and chlorophyl and carbon, while the ocean and the atmosphere do better still by storing heat on an enormous scale, and distributing it where man needs it; many natural minerals store heat and light and electricity, and part with them for man's uses; the earth itself is supposed to be a storehouse of energy; and the sun is admitted to have stored all sorts of energy in almost infinite volume, for no other known, intelligent use than the purposes of man. Further, steel stores elastic energy better than any vegetable life can do it; every molecule stores cohesive energy better than any animal life does it; while all intelligent people are still staring, with stupid bewilderment, at the storage power of an atom of radium. Matter indeed, is energy itself, and its economies first made organic life possible by thus correcting nature's tendency to waste.

Even less can the physicist admit that man alone enjoys the supernatural power of consciously reversing nature's processes, and of restoring her dissipated energies to their lost intensity. From the physicist's point of view, Man, as a conscious and constant, single, natural force, seems to have no function except that of

dissipating or degrading energy. Indeed, the evolutionist himself has complained, and is still complaining in accents which grow shriller every day, that man does more to dissipate and waste nature's economies than all the rest of animal or vegetable life has ever done to save them. "Already,"—one may hear the physicists aver—"man dissipates every year all the heat stored in a thousand million tons of coal which nature herself cannot now replace, and he does this only in order to convert some ten or fifteen per cent of it into mechanical energy immediately wasted on his transient and commonly purposeless objects. He draws great reservoirs of coal-oil and gas out of the earth, which he consumes like the coal. He is digging out even the peat-bogs in order to consume them as heat. He has largely deforested the planet, and hastened its desiccation. He seizes all the zinc and whatever other minerals he can burn, or which he can convert into other forms of energy, and dissipate into space. His consumption of oxygen would be proportionate to his waste of heat, and, according to Kelvin, 'If we burn up our fuel supplies so fast, the oxygen of the air may become exhausted, and that exhaustion might come about in four or five centuries' (Life, 1002). He startles and shocks even himself, in his rational moments, by his extravagance, as in his armies and

armaments which are made avowedly for no other purpose than to dissipate or degrade energy, or annihilate it as in the destruction of life, on a scale that rivals operations of nature. What is still more curious, his chief pleasures, so far as they are his own invention, consist in gratifying the same unintelligent passion for dissipating or degrading energy, as in drinking alcohol, or burning fireworks, or firing cannon, or illuminating cities, or deafening them by senseless noises. Worse than all, such is his instinct of destruction that he systematically exterminates or degrades all the larger forms of animal life in which nature stored her last creative efforts, while he breeds artificially, at great expense of his own energies, and at cost of the phosphorus and lime accumulated by nature's mostly extinct organisms, the feebler forms of animal and vegetable energies needed to make good the prodigious waste of his own. Physicists and physiologists equally complain of these tendencies in man, and a large part of their effort is now devoted to correcting them; but the physicist adds that, compared with this enormous mass of nature's economies which man dissipates every year in rapid progression, the little he captures from the sun, directly or indirectly, as heat-rays, or water-power, or wind-power, is trifling, and the portion that he restores to higher intensities would be insignificant in

any case, even if he did not instantly degrade and dissipate it again for some momentary use."

Against this indictment of man's wastefulness, not even Darwin, fond of paradox as he was, would have cared to champion man's defence, and since Darwin wrote, the waste of energy has been doubled again and again. On this point, the evolutionist stands at great disadvantage. Astronomers are given to holding the sun to a sort of moral accountability because it utilizes only about $\frac{1}{2,300,000,000}$ of its heat,—or gravitation, or electricity, or whatever energies it dissipates,—on any known work, and degrades the rest indefinitely in space; but, if their relative resources are taken into account, the sun is,—according to the physicists,—a model economist compared with man. The sun can keep up its expenditure indefinitely, subject to occasional fits of economy; while man is a bottomless sink of waste unparalled in the cosmos, and can already see the end of the immense economies which his mother Nature stored for his support. Almost all other organisms, especially the lowest, were good economists, and inorganic matter seemed to be perfect. No physicist dares guess within millions of years the date when the carboniferous forests stored their carbon; but it was an affair of to-day compared with the date when steel stored its elasticity, or the magnet its attraction, or

uranium its radiation, or the earth its gravitation; yet the chemists seem unconscious that any of the forms of matter actually known to them, unless it be the radiating activities, have lost or are now degrading their energies, while the higher animals have passed, and are still passing, like dreams.

The evolutionist knows all this quite as well as the degradationist, and has never held man's extravagance for a virtue except in a sense of his own, as though he were to adopt the physicist's figure, and say that the enormous fall of potential which he obtained from all this combustion was utilized or converted by him, and reappeared in the intenser form of energy called Thought. Considered as a mode of motion, Thought was far more valuable than Heat or Electricity, and much more easily stored; it was subject to the usual mechanical laws of attraction and inertia; its analogy with Electricity was declared to be close; and its usefulness was the more important because it had been so carefully economized that its full reservoir could be drawn upon,—as in Universities and schools and libraries,—by all the world without limit, like the oxygen of the air.

In literary language, Thought was God;—Energy in abstract and absolute form;—the ultimate Substance; —*das Ding an sich.* Most philosophy rested on this

idea that Thought is the highest or subtlest energy of nature. The sun is an immense energy, but does its work on earth only by expending 2,300,000,000 times more than equivalent energy in space, while Thought does more work without expending any equivalent energy at all. By placing a lens in the path of the sun's rays, it restores to any given intensity the radiation which had been indefinitely diffused. By cheap mechanical instruments it raises or lowers the intensity of the electric current. By slight motions of the hand it sets chemical energies at work without limit; and, what stamps the act as divine, it impresses the result with FORM.

Thus the dispute drifts back again to the middle-ages. The physicist can no more compromise with the evolutionist than Lord Bacon could compromise with the Schools. Galileo could as well admit that Joshua had held up the sun, as Kelvin could admit the power of man to reverse the dissipation of solar energy, and thus to produce a new energy of higher potential, called Thought; yet even if, for the argument's sake, he had done so, the dispute would not have been settled. If Thought were actually a result of transforming other energies into one of a higher potential, it must still be equally subject to the laws which governed those energies, and could not be an independent or supernatural force. Turn or twist the dilemma as they

pleased, they returned to it in spite of themselves, and would do no better if the evolutionist were to give way, in his turn, and offer the concession he had refused.

"On reflection," he might say, "I will grant that thought may radiate its energy away, like electricity and heat; a figure which, I understand you to say, suits your law of degradation while leaving me free to prove, if I can, its power to rise in intensity. Where will this concession bring me out? You admit that the sun maintains its energy indefinitely by contracting its volume. Are you willing to admit that Vital Energy, regarded as a volume or society, might conceivably do the same thing? and if so, what then?"

To this, the physicist must be supposed to reply,—however unwillingly,—that nothing would suit him better than such a concession,—which he had in fact begun by offering,—but that, in common honesty, he was bound to regard it as a total surrender of the evolutionist claims. The mind either was an independent energy, or it was not. If evolutionists conceded at the outset that it was not, then the mere figure mattered nothing; the dispute ended of itself, and the law of thermodynamics went into operation. If, on the contrary, the evolutionists meant to insist on independence, they would gain little or nothing by proving

a power to prolong life,—animal, vegetable, or physical, —by aggregation or by concentration; they merely changed the numerical value of the variable called Time:—

"No doubt," might a physicist be imagined to continue, "you can, if you like, give to this variable called Time a value approaching infinity, and this is your ordinary loop-hole of escape. You are welcome to it, as far as concerns us physicists, and we will help you to get it, and stay in it, if you will only leave us in peace without annoying us by your unscientific, ignorant objections which would put a stop to science altogether, if you insist on them. Yet when we look at it from your point of view, we cannot see what you gain by increasing the element of Time. You want to increase not Time but Tension. You do not want to preserve society as it is,—and if you did want it, you could not do it; you want to raise the level of its Vital Energy. Now, we admit that Vital Energy is not mere attraction or cohesion or elasticity, but we say that it is limited by the same laws, and we know little about any of them except their limitations. Of course, the mind can reverse them in action, but so can they reverse each other, and the mind too; as cohesion reverses gravitation; and a drop of water reverses cohesion; and one degree of heat reverses all. A watch-spring stores

elasticity better than the mind stores thought. Any chance bit of obsidian or crystal can set forests afire, without calling itself intelligent. A fall of one degree in temperature gives form to an icicle, without claiming to be divine. A summer shower develops electricity at a tension sufficient to reverse the energy of as many minds as get in its way, without asserting the smallest pretension to reverse natural laws. Nature is full of rival energies; and,—for anything we know,—may once have been full of hostile energies; but, hostile or friendly, its infinite variety of Forms, Directions, Intensities, and Complexities, had taken order, from the smallest electron and ion to the widest range of stellar space measured by the most powerful light-ray, going through every possible form of physical evolution before man,—or his instinct,—or his reason,—or any other animal, or vegetable, or organic life, or vital energy, ever stirred!"

If then the evolutionist, irritated by treatment which seems a far-off echo of the remarks of the King of Brobdingnag to Gulliver nearly two hundred years ago, should still insist upon his mind being the highest possible intensity of energy on account of its consciousness, the degradationist might probably lose his temper and his manners outright, to the point of breaking out:—

"The psychologists have already told you that Consciousness is only a phase in the decline of vital energy;—a stage of weakening will. We physicists, even less than you Darwinists, deny the intensity of the Will, but we know it to be stronger in the Scarab or the Scorpion, where it is unconscious, than in Monkey or Man, where it is conscious; while we watch, over and over again with abject incredulity, the apotheosis of a butterfly or the flowering of an orchid, which reveal to our scientific sense an intensity of vital energy out of all comparison with that of man. We never tire of marvelling at the essence of substance;—at the energy of the atom or the glow-worm; but this is the motive behind our whole thermodynamic law.

"The highest intensities of nature, such as produced the atom and the molecule, were precisely the earliest on our scale. Of the vital energies in the order of time we cannot pretend to know much, since all the types seem to have first developed themselves, during a great many millions of years, in water, or underground, in conditions indefinitely varied and altogether unknown; but the moment an animal appears above-ground, it turns out to be a Silurian Scorpion, a type of the intensest vital energy that ever lived, if one can trust the entomologists. Next, in the Carboniferous, we happen first on a dragon-fly with 'a spread of wing much

exceeding two feet' (Dana, 702). Carboniferous insects, like carboniferous forests, suggest intensities indefinitely stronger in creative power than any energies known to be at work to-day. In fact, no creative energies whatever are known to be at work today, unless it be the radiating activities. Mere heat creates nothing. Neither heat nor its absence accounts for any of the problems of vital energy,—neither for the cell, nor the form, nor the movement, nor the consciousness, nor the descent, nor the inheritance, nor the intelligence, of organisms, nor does motion account for direction. No intelligent man now-a-days is satisfied with a purely mechanical formula.

"Palaeontologists talk only of specialization, as though the more elaborate type were the higher intensity. The opposite is more likely to be true. Geology suggests plainly that, after at least fifty million years of conditions which made life impossible except under water, these anarchic forces dissipated themselves so far as to settle into an equilibrium which showed itself on land in the wild exuberance of the carboniferous forests, and which then developed into the wilder exuberance of the Eocene mammals. How long this exuberance lasted, Saporta has told us; and he is also authority for the fact,—not the theory, I say,—that the equilibrium was overthrown by the steady dissipation of energy.

Gaudry, another sufficient authority, has added that vital energy fell step by step, and phase by phase, with solar energy. The geologists in general seem to agree with the astronomers in teaching that both forms of energy will continue to fall in intensity until both disappear. Meanwhile we are perfectly at liberty to teach that the relative intensity of each phase measured the relative intensity of each creation of land-organisms in the order of time. We are not only at liberty to do it; we are logically compelled to insist upon it. No other order of sequence can be made to accord with the positively miraculous properties which defy explanation in organic as in inorganic nature.

"We all remember the desperate efforts that Darwin made to fit within a uniformitarian schedule these violent leaps in the energy of evolution, but we seldom realize how difficult he found the task of convincing himself that his own scheme was convenient. When he said, as he often did, that he never thought of the eye without a chill,—'the eye, to this day (1860), gives me a cold shudder,'—he meant,—among other things, —that his theory was good for nothing as a convenient means of explaining why the eye should have leaped to perfection from its start, when it should have been the slowest in the order of evolution. In fact, the eye of the first fish, at the beginning of geological time, was

at least as good as that of his descendant still living unchanged; and the first trilobites, somewhere in Silurian ages, had eyes of twelve or fifteen thousand facets. 'Assuredly,' says Gaudry, 'we marvel at such complication in creatures of such great antiquity, but we cannot conclude that the organ of sight reached its whole perfection in the primary period, for probably the thirty thousand facets of *Remopleurides* were not equal in value to the two beautiful eyes of our actual mammals.' Such a *probably* might well cause Darwin a chill; but had he gone on to say that the decline of the Tertiary quadrupeds caused him a worse shudder, he would have said only what Dana seemed to feel, and what strikes every physicist with astonishment when he reads it in Dana, about the universal stunting of animal life in recent times. In South America alone, during and since the glacial epoch, the extinct species of quadrupeds number more than a hundred, while, among the peculiarly South American order of Ant-eaters, the extinct species were more numerous than all those that 'now exist in that part of the continent, and were far larger animals.' In Australia the Marsupials prove the same law: 'As on the other continents, the moderns are dwarfs by the side of the ancient species.' As a universal rule, the fact of dwindling size holds true of a large part of the mammals, including elephants and

herbivores as well as many carnivores, edentates, rodents and marsupials: 'The kinds that continued into modern time became dwindled in the change wherever found over the globe, notwithstanding the fact that genial climates are still to be found over large regions' (Dana, 997). Neither Kelvin nor Faye, neither Lapparent nor Flammarion, asserted the brutal facts of degradation nearly so strongly as Dana.

"To this law, which has already reduced us to 'living in an impoverished world,' you evolutionists require us physicists, under some mysterious penalty, to make for you an exception in favor of man. We cannot do it. We are willing to yield much of the old mechanical ground. We grant that we cannot explain why, in man or in molecule, the primitive energies of nature took directions which imply,—in our limited experience,—a reasoning forethought. Cause is a transcendental problem beyond our grasp. We no longer venture even to assert that we know the creative forces at all. We say only that in the world which we do know, we can see nothing supernatural in action. Infinite complication we admit, but no ultimate contradiction. Sooner or later, every apparent exception, whether man or radium, tends to fall within the domain of physics. Against this necessity, human beings have always rebelled. For thousands of years they have stood apart, superior to

physical laws. The time has come when they must yield.

"The claim that Reason must be classed as an energy of the highest intensity is itself unreasonable. On the contrary, Reason is the last in time, and therefore the lowest in tension. According to our western standards, the most intense phase of human Energy occurred in the form of religious and artistic emotion,—perhaps in the Crusades and Gothic Churches;—but since then, though vastly increased in apparent mass, human energy has lost intensity and continues to lose it with accelerated rapidity, as the Church proves. Organized in society, as a volume, it becomes a multiplied number of enfeebled units, on which, like the eye in insects, reason acts as an enormously multiplied lens, converging nature's lines of will, and taking direction from them, but adding nothing of its own. Man has, indeed,—or had,—in a few of his stems, some faculty for artistic expression, not nearly so strong as that of some plants, or some butterflies, or some birds, but more varied. This instinct he probably inherited from an earlier, more gifted, animal; but as a creative energy he inherited next to nothing. The coral polyp is a giant beside him. As an energy he has but one dominant function:—that of accelerating the operation of the second law of thermodynamics. So far as his reason acts as an energy

at all, it is a miraculous invention for this purpose, which inspires wonder and almost worship, but in strictness and reason does not work,—it is only a mechanism;—nature's energy, which we have agreed to call Will, that lies behind reason, does the work,—and degrades the energy in doing it!"

Evidently, on these lines, no sort of agreement is possible. The two figures contradict each other beyond the chance of conciliation. Of course the contradiction has been slightly exaggerated to make it clear; but if the physicist had not himself lost the high literary potential of Swift and Voltaire, he would exaggerate to much better purpose, and would handle the unfortunate creature called Man in a temper such as any one may renew who cares to go back to Bunyan or Dante or the Bible, not to mention the Prophets in particular; but he would convince no one. Man refuses to be degraded in self-esteem, of which he has never had enough to save him from bitter self-reproaches. He yearns for flattery, and he needs it. The contradiction between science and instinct is so radical that, though science should prove twenty times over, by every method of demonstration known to it, that man is a thermodynamic mechanism, instinct would reject the proof, and whenever it should be convinced, it would have to die.

If the deadlock were a new thing, the situation would

not be so difficult, but the history of the last five hundred years tells of little else. Man began by usurping the rank of lord of creation. Galileo and Newton succeeded in deposing him, much against his will,—as the Church very candidly confessed,—but he has never despaired of reinstating himself by means of his Reason. The doctrine of evolution seemed, in the nineteenth century, to favor him. For fifty years, society flattered itself that science stood solidly behind it, lifting it up from lower powers to higher, and restoring it to its old rank and self-respect as child and heir to the infinite. The contrary assertion of Kelvin had no effect upon it whatever. Indeed if Eduard von Hartmann is right, society deliberately chose to be silent about the direction of physics, and refused to think or talk about it; but silence has never stopped this dispute, at least in western civilization, since the martyrdom of Prometheus, and merely hurried the moment when, on scientific principles, another catastrophe, like that of the Newtonian philosophy, became imminent.

William Thomson and Clausius, Helmholz and Balfour Stewart, asserted and reiterated the certainty of this catastrophe, in vain, as Descartes had asserted it,—also in vain,—two hundred years before; but Descartes offered a compromise, and in that respect differed from Kelvin. Descartes proposed to free man from material

bondage, provided he might mechanize all other vital energies. Society rose in arms to protect the dog, and so defeated the scheme, leaving the world to go on asserting two contradictory principles in the same breath, down to the present day, to the undiminished embarrassment of Universities, and with little perceptible change in the situation, except that the Universities of to-day hesitate to assert with confidence the old conviction of spiritual authority, showing in this respect a distinct decline in energy; while technical instruction has reached,—or seems on the verge of reaching,—the point where it must insist on the universal application of its thermodynamic law.

Since compromise of principle seems to be out of the question, there remains only the resource of direct conflict. Each party is thrown back on the horns of a dilemma,—the same old dilemma of Saint Augustine and Descartes,—the deadlock of free-will. The professor of physics will ask his colleague, the professor of history, to explain the process by which energy raises its own potential without cost, since this has been an object greatly desired by schoolmasters from the earliest known ages, and would singularly simplify the professorial accounts. The teacher of history, who has trouble enough already in trying to raise the potential of his scholars' energy, can only retort by asking his colleague

to show how his own teaching proves progressive enfeeblement and degradation of quality. The degradationist might be quite ready to admit it, and quite competent to prove it, but he knows that he has already turned his own thermodynamic law into a means of convincing society of the contrary. Since the year 1830, when the great development of physical energies began, all school-teaching has learned to take for granted that man's progress in mental energy is measured by his capture of physical forces, amounting to some fifty million steam horse-power from coal, and at least as much more from chemical and elementary sources; besides indefinite potentials in his stored experience, and progressive rise in the intensities of the forces he keeps in constant use. He cares little what becomes of all this new power; he is satisfied to know that he habitually develops heat at 3000° Centrigrade and electricity by the hundred thousand volts, from sources of indefinitely degraded energy; and that his mind has learned to control them. Man's Reason once credited with this addition of volume and intensity, its victory seems assured. The teacher of history need then trouble himself with no further doubts of Evolution; but the teacher of physics seems—at least to an ignorant world whose destiny hangs on the balance,—very much required to defend himself.

Although this form of physical psychology is less than a hundred years old it has already taken possession of society so completely as to serve it, in place of the old religious and mechanical formulas, for a philosophical foundation. The historian has a right to use it as such; but according to the understanding of the physical law already discussed, one would think physicists debarred from admitting it. To them it should seem an illusion, although one difficult to deal with; but, as far as a bystander has means of judging, they would still be at liberty to turn the dilemma about, and seek to impale their antagonist on the reversed horn, by suggesting that the theory of tropism or induction, or of physico-chemical relations in general, seems to require that the psychical will, under such conditions, should not absorb physical energy so much as physical energy would absorb the psychical will. Two similar energies, when in contact, would tend to a common level; force, if powerful enough, would control thought; the ocean would dissolve the crystal of salt; so that, if the evolutionist should insist on identifying the quality of his psychical energy with the quantity of his steam- or water-power or electric voltage, the physicist would expect to see the psychical potential of society vanish as suddenly as the potential of a Leyden jar.

Perhaps the Universities might be quicker than the

technical schools to see the point of this retort, since they claim, in theory, to deal with quality rather than with quantity, and possibly some professors have noticed that quality may sometimes suffer from contact with volume. The idea is not precisely new,—far from it!—even beyond the pale of European Universities, portions of society have shown a somewhat enfeebled instinct of revolt against the psychical processes of the press and the public. Various writers have discussed the effect of dissolving society into a single mixture; even a name,—panmixia—has been made for it. Nothing is commoner than the prejudice against mechanical energy as a weakener of nervous energy whenever it gets control, as in manufacturing towns; or the belief that great masses of people under uniform conditions tend to a mechanical uniformity of mind, as in agricultural districts; but the interest of the subject lies less in the application of the theory than in the shape which the theory would have to take in order to conform with the rest of the law of thermodynamics. Physicists know best what their mathematical formulas for electricity and gases and solutions are; historians have no right to meddle with the methods of colleagues in rival departments; but they cannot help feeling curiosity to know whether Ostwald's line of reasoning would logically end in subjecting both psychical and physico-chemical

energies to the natural and obvious analogy of heat, and extending the law of Entropy over all. (Ostwald, "Vorlesungen," Leipzig, 1902, p. 398.)

Few physicists would be likely to see any scientific sense in this personal application of their law, and no one is readier than the historian to admit that Vital Energy is probably not so simple as any formula that he could state, or understand if stated to him. The most ardent lover of paradox,—the most inveterate humorist,—would hardly think it worth his while to follow a train of reasoning which would surely immolate physics and metaphysics together. Such amusements seem to be reserved for astronomers; but neither historians nor sociologists can afford to let themselves be driven into admitting that every gain of power,—from gunpowder to steam,—from the dynamo to the Daimler motor,—has been made at the cost of man's—and of woman's—vitality. The mischiefs thus charged upon Reason would not end there. Metaphysics as well as mathematics would measure enfeeblement; philosophy as well as mechanics would mark degradation; the Universities as well as the technical schools would alike close their doors without waiting for the sun to grow cold.

Direct conflict, therefore, seems to be as barren as compromise. Heretofore in human experience, such reasoning would have been dismissed at once as only the

usual futile attempt at reduction to the absurd. That it would pass for such in a University of to-day is an open question; it sounds rather like another way of saying what Arndt, Branco, and Hopf, as well as Rousseau and a thousand others have said for the past hundred and fifty years; but in any case it has no value for teachers, since it leads only to the stoppage of teaching altogether. If the teacher of history cares to contest the ground with the teacher of physics, he must become a physicist himself, and learn to use laboratory methods. He needs technical tools quite as much as the electrician does; large formulas, like Willard Gibbs' Rule of Phases; generalizations, no matter how temporary or hypothetical, such as all mathematicians use for the convenience of their scholars. The whole field of physics is covered with such temporary structures, mere approximations to truth, but in constant demand as tools. Mathematicians practise absolute freedom; they have the right—and use it—to assume that a straight line is, or is not, the shortest distance between two points, as they please. In the whole domain of science, no field of cultivation is poorer in such labor-saving devices than that of human history, yet Man, as a form of energy, is in most need of getting a firm footing on the law of thermodynamics. One cannot doubt that Lord Kelvin could have suggested half-a-

dozen figures which would answer the purpose, although he might very well have refused to waste his own stock of vital energy in the effort to prove his thermodynamic ascent from a hypothetical eocene lemur, or even from a duck-billed platypus; neither of which would have promised energetic means of saving him from the pitfalls which his keen mathematical instinct would have shown him as the work of his fellow-physicists, planted directly in his path.

Whatever the difficulties, Kelvin would have faced them honestly. He had courage beyond the common, and if the problem had been forced on him as he forced it on others, he would not even have felt himself obliged to obey his own laws. Almost in his last words he pathetically proclaimed that his life was a failure in its long effort to reduce his physical energies to a single term. Dying he left the unity, duality, or multiplicity of energies as much disputed as ever. "A certain anarchy reigns in the sciences of nature's domain," says M. Lucien Poincaré, who is regarded as a sufficient authority; "any venture may be risked; no law appears rigorously necessary." Within the past year Professor Joly of Dublin has seriously risked such a venture in his "Radio-activity and Geology; an account of the Influence of Radio-active Energy on Terrestrial History" (London, 1909); and although the general reader

gathers from it mainly the conclusion that physical science is more or less chaotic, this conclusion is only what he needs to reach before he can begin to deal with vital science, which is all chaos. "We see the middle- and the end-series of the phylogenetic series," says Reinke; "that we do not see the beginning is self-evident, since it was built up in a period of the earth's history which is for us transcendental" ("Einleitung," p. 612); we could not understand it if we did see it. So far as concerns the history of man, every period of the earth's history, beyond its actual condition, is transcendental. The anthropologist knows nothing whatever about it. Among a thousand possible varieties of primitive man, he has scarcely more than two or three doubtful clues to follow, and thus far these lead nowhere.

The single point about which Professor Klaatsch speaks with positiveness approaching temper, is that "the primitive man must not be treated either as morally bad or as intellectually stupid. . . . The primitive man, our ancestor, is to be prized as a being high in rank, who, in many a point of view, in force of individuality and vigor of self-assertion (Kraft der Individualität und Kampfesmut) was the superior of his cultured heirs (seinen Epigonen der Kultur)." Köbner Versammlung der Deutschen Naturforscher und Ärzte. Herbst, 1908.)

Apparently this is the only certain result of sixty years' effort in physics and physiology. Forced back on the logical suicide of asserting or accepting an act of creation, biologists prefer to admit mental enfeeblement, even at the risk of being driven to admit both; so that, if the safety of society should seem now to depend on assuming a multiple cause, as of old on establishing the unity of creation, nothing obliges society to persist in its monist scheme. If the physicist cannot make mind the master, as the metaphysician would like, he can at least abstain from making it the slave.

So little essential is monism, that M. H. Poincaré lately startled the world by avowing that physicists used that formula only because all science would become impossible if they were not allowed to assume simple hypotheses ("La Science et l'Hypothèse," p. 173); but this mental need of unity is also a weakness, which gives the degradationist an artificial and altogether unfair advantage. The convenience of unity is beyond question, and convenience overrides morals as well as money, when a vast majority of minds, educated or not, are invited to live in a complex of anarchical energies, with only the privilege of acting as chief anarchists. Bewildered and outraged they reject the image; but they find that of diffusion or degradation so simple and so natural as to satisfy every want. The Darwinian readily

admits that Kelvin's sun accounts for evolution better than Darwin's did; and he is only too ready to drop all the school-phrases,—to call the process Transformation, and so, quietly, surrender the issue. He is equally ready to admit that Darwin never supplied a motive power that should vary in force with the phenomena; he might even go so far as to concede that the want of such an energy had embarrassed biology nearly to the point of paralysis; while he must honestly grant that Kelvin began mathematically by giving himself, from the start, all the power he needed, in the degree in which he needed it, so that his system supplied its own force,—like the Niagara River,—by degrading its own energies. Simplicity may not be evidence of truth, and unity is perhaps the most deceptive of all the innumerable illusions of mind; but both are primary instincts in man, and have an attraction on the mind akin to that of gravitation on matter. The idea of unity survives the idea of God or of Universe; it is innate and intuitive. Thought floats much more easily towards than against it, and from the moment when heat, or electricity, or thought, or any other form or symbol or medium of energy, was likened to a falling substance tending to an ultimate ocean of Entropy, nothing was simpler than to plot out the ordinates and abscissas that marked its curve of evolution. Astronomy, geology, palaeontology,

biology, psychology, could all move majestically down the decline.

Perhaps the feature of the scheme that was most repulsive to instinct, was most seductive to science,—its fatal facility in accounting for Reason. All organisms would tend to develop nervous systems when dynamically ill-nourished. As the Drosera is represented to have taken to a diet of insects when it could no longer nourish itself sufficiently as a vegetable, or as a tree may throw out wider and deeper roots in the degree that complexity might bring moisture, so the vital energy which had developed in the exuberance of physical quantity so long as its dynamic supplies were in excess of its needs, would turn itself, as its conditions were impoverished, into those "connecting, or, as they are technically called, association-fibres, which make nerve-currents work together as they could not without being thus associated." Thought then appears in nature as an arrested,—in other words, as a degraded,—physical action. The theory is convenient, and convenience makes law, at least in the laboratory.

In this freedom of handling his energies the physicist enjoys another easy advantage over the sociologist. As already pointed out, the physicist is safe from interference so long as he can still promise expansion of power, or relief from pain; while the oldest and driest

professor of history would smile at the idea of trying to imitate his vivacious colleague by telling his students, at the opening of the collegiate year, that, "as an approximately correct working hypothesis," he should proceed to treat the history of modern Europe and America as a typical example of energies indicating degradation "with headlong rapidity" towards "inevitable death." Probably he would have no more difficulty than the physicist has, in making his material fit his figure; history can be written in one sense just as easily as in another; but however perfect this figure might seem to him he would not think it suited to the interests of the students or of the University, in spite of the fact that the University has never committed itself to the contrary. Indeed he could truthfully say that the Universities in Europe have never preached upward evolution at all.

History began with admitting as its starting-point that the speechless animal who raised himself to the use of an inflected language must have made an effort greater and longer than the effort required for him, after perfecting his tongue, to vulgarize and degrade it. Even after descending to the familiar facts of relatively recent evolution historians never teach that Egyptian pyramids and tombs show childlike inferiority to the tombs and temples of Berlin. Artists have never been

known to illustrate their lectures on the history of their art by showing how much the sculpture of Pheidias and Praxiteles might have been improved by an acquaintance with the sculpture of London. Dramatists do not hold up to derision the feebleness of Aeschylus or the folly of Aristophanes before the gigantic force and genius of Sardou and Rostand on the Paris stage. American professors do not read Pindar or Lucretius aloud in order to suit the intelligence of their children in the nurseries of New York and Chicago. Historians seldom express contempt for Thucydides, and still devote volumes to Alexander the Great and Julius Caesar. They have obstinately shirked the duty of applying the law of elevation to their view of history, but rather have bitterly opposed it. Even the prophet of progress in the English school,—Macaulay,—could not resist the old trick of reviving a conventional barbarian to gloat, "in the midst of a vast solitude,"—over the exhausted energies of England. Histories invariably use Kelvin's figure whenever it is convenient, and talk of new races in set terms as so much fresh fuel, or oxygen, flung on the burnt-out energies of empire; while the greatest historical work in the English language is called "The Decline and Fall."

Something less than two hundred and fifty years ago, all the greatest scholars and wits of Europe were dis-

puting the relative superiority of ancients and moderns. Swift's "Battle of the Books" still lives as a sparkling record of it. The moderns, having the advantage of being alive, decided the result in their own favour, but, until the amazing influx of mechanical and physical energies after 1830, the European Universities never seemed clear on the subject, and would be quite likely to-day to reverse the judgment on such evidence as decided the case in 1700. Only an unusually well-informed scholar could say with certainty what the German or French Universities think about the dogma of upward evolution in the year 1910, but their record is a bad one.

On the dogma of Degradation their record is worse. If the human race is to depend on their suffrages, its state is a parlous one. For a thousand years, as long as religion held sway, teachers were not merely permitted —they were obliged—to condemn the human race,—with rare exceptions, due only to the pity of God,—to eternal degradation following the near end of the world. After 1500 the Church very slowly lost its control of education, but the attitude of the schools changed little in regard to human history. In the University as in the pulpit, the standards of excellence remained among the Greeks, or the Romans, or the Jews, when it was not carried back to the Garden of Eden. In the nineteenth

century, every one knows how eagerly the public responded to Wagner's resuscitation of the Middle Ages. By most artists modern life is assumed as decadence. What is most striking of all, the Universities have begun again,—within fifty years,—to announce through their astronomers the approaching demise of the solar system; through their geologists, the death of the earth and its occupants; through their physicists, the years still left for suns to shine, and the ultimate destiny of the celestial universe to become atomic dust at —270° Centrigrade; while their anthropologists point out the rapid exhaustion of the race, and their newspapers day by day proclaim its steady degradation. What makes the matter infinitely worse is the common, daily experience that, not only in Universities but also at every street-corner of every European city, on every half-holiday, hundreds of thousands of men are taught to believe with delight, that society, down to the present day, is an unnatural abortion, sustained by perverted illusions, and destined to immediate suicide. To such a point has this habit of teaching gone, that society itself, at every national and municipal election, is seen physically trembling; perplexed and confused; feeling its way; conscious of its dangers; anxious to do right; ashamed of the sores which,—as it is solemnly assured, —disfigure its surface, and of the hideous tumors which,

—as it is incessantly told,—are ravaging its vitals; half-willing to be sacrificed, like Iphigenia, but timidly shrinking from staking the life, described as so worthless, on the gambler's chance of winning something less wretched in an unknown beyond.

Among all these voluble prophets, the historian alone may not discuss the problem for respect of youth, lest he should make still more serious an issue which was serious before schools began.

If the silent, half-conscious, intuitive faith of society could be fixed, it might possibly be found always tending towards belief in a future equilibrium of some sort, that should end in becoming stable; an idea which belongs to mechanics, and was probably the first idea that nature taught to a stone, or to an apple; to a lemur or an ape; before teaching it to Newton. Unfortunately for society, the physicists again abruptly interfere, like Sancho Panza's doctor, by earnest protests that, if one physical law exists more absolute than another, it is the law that stable equilibrium is death. A society in stable equilibrium is—by definition—one that has no history and wants no historians. Thomson and Clausius startled the world by announcing this principle in 1852; but the ants and bees had announced it some millions of years before, as a law of organisms, and it may have been established still earlier, in more convincing form, by

some of the caterpillars. According to the recent doctrine of Will or Intuition, this conclusion was the first logical and ultimate result reached in the evolution of organic life; but the professor of history who shall accept the hymenoptera and lepidoptera as teachers in the place of Kelvin and Clausius, will probably find himself in the same dilemma as before. If he aims at carrying his audience with him, he will have to adopt the current view of a society rising to an infinitely high potential of energy, and there remaining in equilibrium, the only view which will insure him the sympathy of men, as well as—probably—of caterpillars; but if he wants to conciliate science, he will have to deride the idea of a stable equilibrium of high potential, and insist that no stable social equilibrium can be reached except by degrading social energies to a level where they can fall no further, and do no more useful work. Perhaps this formula, too, may please many students, whose potential of vital energy,—or, in simpler words, whose love of work,—is less archaic than that of the ants and bees; but as a matter of practical teaching,—as a mere choice between technical formulas,—the two methods result in the same dilemma for the old-fashioned evolutionist who clings to his ideals of indefinite progress. Between two equilibriums, each mechanical, and each insisting that history is at an end, lost forever in the

ocean of statistics, the classical University teacher of history, with his intuitions of free-will and art, can exist only as a sporadic survival to illustrate for his colleagues the workings of their second law of thermodynamics.

To some extent, already, he finds himself actually in this awkward situation where his colleagues betray impatience at his continued existence. With singular unanimity, the polite, but embarrassed authorities agree that history is not a science, and show marked unwillingness to permit that it shall ever, with their consent, become one. Except on their own terms, they will have nothing to do with human evolution, and their terms commonly require that they should treat man as a creature habitually striving to attain imaginary ideals always contrary to law. His Will and that of Nature have been constantly at strife, and continue to be so, under the Baconian philosophy and the law of *Energetik,* as decidedly as under the scholastic philosophy and the Summa of St. Thomas Aquinas. Even the friendly Vitalist treats his brother Vitalists with candor not to be mistaken for compliment, because, "in the history of humanity there is always only so much science as there is *no* History"; while the most *naïf* of all the historian's *naïvetés* is his favorite notion that the "understanding" of a problematic humanity can be fur-

thered by adding to it a more problematic phantom of Descent. (Driesch, "Naturbegriffe und Naturutheile." Leipzig, 1904, p. 237.) In truth, one is driven to admit that "the theory of descent," as Von Zittel says, "has introduced new ideas into descriptive natural history, and has given it a higher purpose; but we must not forget that it is still only a theory, which requires to be proved."

On this point, the professor of history who has any smattering of special training, knows all that he needs to know. He is as free as ever he was to go on compiling tables of dates, or editing, or reëditing so-called "documents," or seeking to infuse into the memories of his students a sufficient acquaintance with the statute Quia Emptores. He has fully made up his mind either for or against the existence of any philosophy at all, as well as whether he is required to lecture on such a philosophy in case it does, or does not, exist. Every competent teacher of history is supposed, justly or unjustly, to know his Herbert Spencer and Auguste Comte, even if not his Lamprecht. When his physiological colleagues ridicule his aspirations to science, the professor of history seems little disposed to resent their attitude, but rather encourages it; and he is right, if they are right, in doing so; but, none the less, he finds himself thus placed, for the first time in three

hundred years, face to face with a painful, if not a vital problem. In one respect his dilemma is worse than in the sixteenth century, since Bacon's physical teaching aimed at freeing the mind from a servitude, while the law of Entropy imposes a servitude on all energies, including the mental. The degree of freedom steadily and rapidly diminishes. Without rest, the physicists gently push history down the decline, as yet scarcely conscious, which they are certain to plot out by abscissae and ordinates as soon as they can fix and agree upon a sufficient number of normal variables, not with conscious intention but by unconscious extension. Every reader of current literature knows that the subject is touched by half the books he reads, and that the most popular are the most outspoken. Few volumes are more widely known than M. Gustave Le Bon's "Physiologie des Foules" (1895), which closes with the following paragraph:—

"That which formed a people, a unity, a block, ends by becoming an agglomeration of individuals without cohesion, still held together for a time by its traditions and institutions. This is the phase when men, divided by their interests and aspirations, but no longer knowing how to govern themselves, ask to be directed in their smallest acts; and when the State exercises its absorbing influence. With the definitive loss of the

old ideal, the race ends by entirely losing its soul; it becomes nothing more than a dust of isolated individuals, and returns to what it was at the start,—a crowd."

Under the thinnest veil of analogy the physicist-historian, with scientific calmness, condemns our actual society as he condemns the sun; for the "crowd" which Gustave Le Bon declares to be the end of social evolution is not at all the same "crowd" that made its beginning, and is wholly incapable of doing useful work. In the very teeth of his own arguments and aims Gustave Le Bon in his last volume, "La Psychologie Politique" (Paris, 1910), affirms that this process has already reached its critical point:—

"The surest symptom of the decadence threatening us is the general enfeeblement of characters. Numerous to-day are the men whose energy weakens, especially among the choicest, who should be precisely those who need it most, with the great masters who are placed at the head of nations, as well as with the small chiefs who govern in details, indecision and weakness become dominant. . . . Among the forces of which man disposes, in order to struggle successfully against the powers which constrain him, the Will was always the most active. . . . If we try then to discover why so many nations perished after a long decline,—why Rome, formerly queen of the world, ended by falling under the

barbarian's yoke, we find that these profound falls had generally the same cause,—enfeeblement of the Will" (pp. 374-5). "It was always by this enfeeblement of character, and not by that of intelligence that the great peoples disappeared from history" (p. 295). "It would even seem as though to-day the dead alone gave us energy" (p. 372). This is the teaching of a physicist, but the medical authorities on psychic disease are even more outspoken, frankly asserting as a fact, on which their teaching rests, that the weakness of the Will is the great malady of our epoch. (Grasset, "Idées Medicales." Paris, 1910, p. 56.) Among these medical experts, Dr. Forbes Winslow in his "Recollections" has scandalized the community by his bluntness:—"On comparing the human race during the past forty years," he says (pp. 376-377), "I have no hesitation in stating that it has degenerated, and is still progressing in a downward direction. We are gradually approaching, with the decadence of youth, a near proximity to a nation of madmen. By comparing the lunacy statistics of 1809 with those of 1909, . . . an insane world is looked forward to by me with a certainty in the not far distant future." In fact, the statistics show that in 1809 there was one lunatic in every 418 of the total population of England and Wales; in 1909, there was one in every 278; so that in three hundred years one

half the population should be insane or idiotic. "These are facts!" continues Dr. Forbes Winslow; "they cannot in any way be challenged."

Gustave Le Bon is himself a physicist of wide renown, but he is remarkable also as director of the "Bibliothèque de Philosophie Scientifique," the best known of all recent attempts to lighten the load of technical instruction and of scientific baggage. Among the most recent of these admirable volumes is one on "Degradation" (Paris, November, 1908), by M. Bernhard Brunhes, whose position as Director of the Observatory of the Puy de Dôme guarantees his competence to narrate the story. In one or two paragraphs, with the lucidity which so often distinguishes French thought from that of some other races, M. Brunhes summarizes the values of the two philosophies of history:—

"The preceding remarks give the key to the apparent opposition which exists between the doctrine of Evolution and the principle of Degradation of Energy. Physical science presents to us a world which is unceasingly wearing itself out. A philosophy which claims to derive support from biology, paints complacently, on the contrary, a world steadily improving, in which physiological life goes on always growing perfect to the point of reaching full consciousness of itself in man,

and where no limit seems imposed on eternal progress. Observe that this second idea,—of indefinite progress,—has furnished much more material than the first, for literary development! This is no doubt because the scientific facts on which it is constructed lend themselves to vulgarization far more easily than the scientific facts whose combination forms the principle of Carnot. From our point of view the principle of Degradation of Energy would prove nothing against the fact of Evolution. The progressive transformation of species, the realization of more perfect organisms, contain nothing contrary to the idea of the constant loss of useful energy. Only the vast and grandiose conceptions of imaginative philosophers who erect into an absolute principle the law of 'universal progress,' could no longer hold against one of the most fundamental ideas that physics reveals to us. On one side, therefore, the world wears out; on another side the appearance on earth of living beings more and more elevated, and,—in a slightly different order of ideas,—the development of civilization in human society, undoubtedly give the impression of a progress and a gain" (p. 193).

This, then, is the extreme limit of the physicists' concessions. If a compromise is to be made, it must rest there. The degradationist can so far ameliorate the immediate rigor of his law as to admit that degradation

of energy may create, or convey, an impression of progress and gain; but if the evolutionist presses the inquiry further, and asks where this proposed compromise will lead him as a teacher of young men,—what future reality lies behind the impression of progress,—what amount of illusion is to be reckoned as an independent variable in the formula of gain,—the degradationist replies, quite candidly and honestly, that this impression of gain is derived from an impression of Order due to the levelling of energies; but that the impression of Order is an illusion consequent on the dissolution of the higher Order which had supplied, by lowering its inequalities, all the useful energies that caused progress. The reality behind the illusion, is, therefore, absence of the power to do useful work,—or what man knows in his finite sensibilities as death:—

"Thus Order in the material universe would be the mark of utility and the measure of value; and this Order, far from being spontaneous, would tend constantly to destroy itself. Yet the Disorder towards which a collection of molecules moves, is in no respect the initial chaos rich in differences and inequalities that generate useful energies; on the contrary it is the average mean of equality and homegeneity in absolute want of coördination" (p. 53).

Perhaps an instructor needs a memory extending over

sixty years in order to measure the revolution in thought which such teaching implies. Every right-minded University professor of 1850 dismissed the ideas of Kelvin as he did those of Malthus, Karl Marx, and Schopenhauer, as fantastic. They shocked him partly for their extravagance but chiefly for what he regarded as their destructive pessimism. In 1910 an American professor who should try to get below the surface of thought in Germany, Italy, France, or even in England, would probably incline to the conclusion that Schopenhauer may be regarded as an optimist. In reality pessimists and optimists have united on a system of science which makes pessimism the logical foundation of optimism. History is the victim of both. Let any young student take up the last German book on Biology that happens to fall under his eyes. Within the first hundred pages he is fairly sure to come upon some assertion or assumption of the second law of thermodynamics in its dogmatic form:—

"The *Energetik* of the living organism consists, then, in the last analysis, in the fact that the organism, when left to itself, tends in the direction of a stable equilibrium under the surrender of energy to the outer world. The reaching of the stable equilibrium,—even the mere approach to it,—means death. In this respect the organism acts like a clock that has run down."

(Reinke, "Einleitung in die theoretische Biologie," p. 152).

In 1852, Thomson contended himself by saying that a restoration of energy is "probably" never effected by organized matter. In 1910, there is nothing "probable" about it; the fact has become an axiom of biology. In 1852, any University professor would have answered this quotation by the dry remark that society was not an organism, and that history was not a science, since it could not be treated mathematically. To-day, M. Bernhard Brunhes seems to feel no doubt that society is an organism, and the most marked tendency of recent historians is to reassert in almost dogmatic terms the historical fact that man is the creature, not the creator, of the social organism. Among living historians Eduard Meyer stands near the head, and his introduction begins with the axiom that "the whole mental development of mankind has, for its preliminary assumption, the existence of separate social groups."

"Above all, the weightiest instrument of men, Speech —which first makes the Man, and first makes possible the growth of our systematic Thought,—has not been a casual creation of individuals or of the relation between parents and children, but has grown out of the common needs of equals, bound together by common interests and regulated intercourse. But even the inven-

tion of tools, such as the acquisition of Fire, the taming of the domestic Animals, the settlement in Residence, and so on, are possible only within a group; or at least have meaning only so far as what has first and immediately benefited one, becomes the property of the whole community. That, in general, Manners, Law, Religion, and all such moral properties can have arisen only in such relations, needs no discussion. Thus the organization in such ties (Hordes, Stocks) which we meet in experience everywhere we get to know man is not merely just as old, but is far older than the Man; it is the preliminary condition of the existence of the human race altogether." (Einleitung, 7, 8.)

Even the child is the creature of the State Organism, not of the Family. "The generation and bringing up of the descendants lies much nearer the heart of the Social Organism than of the individual man, for to him his own life is his chief interest, while to every social group the actual living members are wholly irrelevant in themselves, and only the momentary representatives of the chain of generations. . . . Hence the compulsion to marriage, and the care for the birth and bringing up of a posterity; hence also the decision whether a new-born child shall live and become a member of the society is for the most part not left to choice of the parent, but falls to the kin or to some other recognized public

authority" (p. 20). In short, the social Organism, in the recent views of history, is the cause, creator, and end of the Man, who exists only as a passing representative of it, without rights or functions except what it imposes. As an Organism society has always been peculiarly subject to Degradation of Energy, and alike the historians and the physicists invariably stretch Kelvin's law over all organized matter whatever. Instead of being a mere convenience in treatment, the law is very rapidly becoming a dogma of absolute Truth. As long as the theory of Degradation,—as of Evolution,—was only one of the convenient tools of science, the sociologist had no just cause for complaint. Every science,—and mathematics first of all,—uses what tools it likes. The Professor of Physics is not teaching Ethics; he is training young men to handle concrete energy in one or more of its many forms, and he has no choice but to use the most convenient formulas. Unfortunately the formula most convenient for him is not at all convenient for his colleagues in sociology and history, without pressing the inquiry further, into more intimate branches of practice like medicine, jurisprudence, and politics. If the entire universe, in every variety of active energy, organic and inorganic, human or divine, is to be treated as clockwork that is running down, society can hardly go on ignoring the fact forever. Hitherto it has often

happened that two systems of education, like the Scholastic and Baconian, could exist side by side for centuries,—as they exist still,—in adjoining schools and universities, by no more scientific device than that of shutting their eyes to each other; but the universe has been terribly narrowed by thermodynamics. Already History and Sociology gasp for breath.

The department of history needs to concert with the departments of biology, sociology, and psychology some common formula or figure to serve their student as a working model for their study of the vital energies; and this figure must be brought into accord with the figures or formulas used by the department of physics and mechanics to serve their students as models for the working of physico-chemical and mechanical energies. Without the adhesion of physicists, the model would cause greater scandal than though the contradictions were silently ignored as now; but the biologists,—or, at least, the branches of science concerned with humanity,—will find great difficulty in agreeing on any formula which does not require from physics the abandonment, in part, of the second law of thermodynamics. The mere formal exception of Reason from the express operation of the law, as a matter of teaching in the workshop, is not enough. Either the law must be abandoned in respect to Vital Energy altogether, or Vital

Energy must abandon Reason altogether as one of its forms, and return to the old dilemma of Descartes.

Meanwhile nothing prevents each instructor from aiming to unite with each of his colleagues in some sort of approach to a common understanding about the first principle of instruction; if each University solves the problem to its own satisfaction, the problem is, in so far, solved for the whole; and nothing need hamper the effort of the Universities to carry the process further, if it promises advantage. If the physicists and physico-chemists can at last find their way to an arrangement that would satisfy the sociologists and historians, the problem would be wholly solved. Such a complete solution seems not impossible; but at present,—for the moment,—as the stream runs,—it also seems, to an impartial bystander, to call for the aid of another Newton.

THE RULE OF PHASE APPLIED TO HISTORY

CHAPTER III

THE RULE OF PHASE APPLIED TO HISTORY

IN 1876-1878 Willard Gibbs, Professor of Mathematical Physics at Yale, published in the Transactions of the Connecticut Academy his famous memoir on the "Equilibrium of Heterogeneous Substances," containing the short chapter "On Existent Phases of Matter," which, in the hands of the Dutch chemists, became, some ten years afterwards, a means of greatly extending the science of Static Chemistry. Although the name of Willard Gibbs is probably to-day the highest in scientific fame of all Americans since Benjamin Franklin, his Rule of Phases defies translation into literary language. The mathematical formulas in which he hid it were with difficulty intelligible to the chemists themselves, and are quite unintelligible to an unmathematical public, while the sense in which the word Phase was used, confused its meaning to a degree that alters its values, and reduces it to a chemical relation. Willard Gibbs helped to change the face of science, but his Phase was not the Phase of History.

As he used it, the word meant Equilibrium, which is in fact the ordinary sense attached to it, but his equilibrium was limited to a few component parts. Ice, water, and water-vapor were three phases of a single substance, under different conditions of temperature and pressure; but if another element were added,—if one took sea-water, for instance,—the number of phases was increased according to the nature of the components. The chemical phase thus became a distinct physical section of a solution, and as many sections existed as there were independent components.

The common idea of phase is that of the solution itself, as when salt is dissolved in water. It is the whole equilibrium or state of apparent rest. It means, perhaps, when used of movement, a variance of direction, but it seems not to have been so much employed to indicate a mere change in speed. Yet the word would apply in literature as well as it does in physical chemistry to the three stages of equilibrium: ice, water, and steam. Where only one component is concerned, the Rule of Phase is the same for chemistry as for general usage. A change of phase, in all cases, means a change of equilibrium.

Whether the equilibrium or phase is temporary or permanent,—whether the change is rapid or slow,—whether the force at work for the purpose is a liquid

solvent, or heat, or a physical attraction or repulsion,—the interest of the equilibrium lies in its relations, and the object of study is the behavior of each group under new relations. Chemists and physicists have turned their studies, for twenty or thirty years past, to these relations, and the various conditions of temperature, pressure, and volume have become more important than the atoms and molecules themselves, while new processes,—osmosis, electrolysis, magnetic action,—have made a new world that is slowly taking the place of the world as it existed fifty years ago; though as yet the old curriculum of thought has been hardly touched by the change.

The new field can be entered only by timid groping for its limits, and with certainty of constant error; but in order to enter it at all, one must begin by following the lines given by physical science. If the Rule of Phase is to serve for clue, the first analogy which imposes itself as the starting-point for experiment is the law of solutions, which seems to lie on the horizon of science as the latest and largest of possible generalizations. As science touches every material or immaterial substance, each in its turn dissolves, until the ether itself becomes an ocean of discontinuous particles.

A solution is defined as a homogeneous mixture, which can pass through continuous variations of com-

position within the limits that define its existence. Solids, as we all know, may be dissolved, but we do not all realize that liquids and gases may also be dissolved, or that a change in composition must accompany a change of phase. As early as 1662, Isaac Voss, in his work, "De Lucis Natura," on the Nature of Light, defined Heat as as "actus dissolvens corpora," the solvent of material bodies; and in 1870, the French chemist Rosenstiehl published a paper in the Comptes Rendues of the French Academy (vol. LXX) suggesting that any gas might be likened to a body dissolved in the medium of the universal solvent, the ether. Reversing the theory, the English and Dutch physicists have solidified every gas, including even helium. The solvent has been suggested or found for every form of matter, even the most subtle, until it trembles on the verge of the ether itself; and a by-stander, who is interested in watching the extension of this new synthesis, cannot help asking himself where it can find a limit. If every solid is soluble into a liquid, and every liquid into a gas, and every gas into corpuscles which vanish in an ocean of ether,—if nothing remains of energy itself except potential motion in absolute space,—where can science stop in the application of this fecund idea?

Where it can stop is its own affair, dependent on its own will or convenience; but where it must stop is a

larger question that interests philosophy. There seems to be no reason for insisting that it must necessarily stop anywhere within the region of experience. Certainly it cannot stop with static electricity, which is itself more obviously a mere phase than water-vapor. The physicists cannot conceive it without conceiving something more universal behind or above it. The logic of former thought, in its classic simplicity, would have taken for granted that electricity must be capable of reduction to a solid,—that it can be frozen,—and that it must also be soluble in ether. One has learned to distrust logic, and to expect contradiction from nature, but we cannot easily prevent thought from behaving as though sequence were probable until the contrary becomes still more probable; and the mind insists on asking what would happen if, in the absence of known limit, every substance that falls within human experience should be soluble successively in a more volatile substance, or under more volatile conditions. Supposing the mechanical theories of matter to be carried out as far as experience warrants,—supposing each centre of motion capable of solution in a less condensed motion,—supposing every vortex-centre treated as a phase or stage of equilibrium which passes, more or less abruptly, into another phase, under changed conditions; must all motion merge at last into ultimate static

energy existing only as potential force in absolute space?

The reply of the physicist is very simple as a formula of experiment; he can carry his theory no further than he can carry his experience; but how far does he, as a matter of fact, carry his habitual, ordinary experience? Time was when experiment stopped with matter perceptible to the senses; but the chemist long ago lost sight of matter so limited. Vehemently resisting, he had been dragged into regions where supersensual forces alone had play. Very unwillingly, after fifty years of struggle, chemists had been forced to admit the existence of inconceivable and incredible substances, and their convulsive efforts to make these substances appear comprehensible had measured the strain on their thought. Static electricity already lay beyond the legitimate domain of sensual science, while beyond static electricity lay a vast supersensual ocean roughly called the ether which the physicists and chemists, on their old principles, were debarred from entering at all, and had to be dragged into, by Faraday and his school. Beyond the ether, again, lay a vast region, known to them as the only substance which they knew or could know—their own thought,—which they positively refused to touch.

Yet the physicists here, too, were helpless to escape

the step, for where they refused to go as experimenters, they had to go as mathematicians. Without the higher mathematics they could no longer move, but with the higher mathematics, metaphysics began. There the restraints of physics did not exist. In the mathematical order, infinity became the invariable field of action, and not only did the mathematician deal habitually and directly with all sorts of infinities, but he also built up hyper-infinities, if he liked, or hyper-spaces, or infinite hierarchies of hyper-space. The true mathematician drew breath only in the hyper-space of Thought; he could exist only by assuming that all phases of material motion merged in the last conceivable phase of immaterial motion—pure mathematical thought.

The physicist, in self-defence, though he may not deny, prefers to ignore this rigorous consequence of his own principles, as he refused for many years to admit the consequences of Faraday's experiments; but at least he can surely rely upon this admission being the last he will ever be called upon to make. No phase of hyper-substance more subtle than thought can ever be conceived, since it could exist only as his own thought returning into itself. Possibly, in the inconceivable domains of abstraction, the ultimate substance may show other sides or extensions, but to man it can be known only as hyper-thought,—the region of pure

mathematics and metaphysics,—the last and universal solvent.

There even mathematics must stop. Motion itself ended; even thought became merely potential in this final solution. The hierarchy of phases was complete. Each phase, measured by its rapidity of vibration, arranged itself in the physical sequence familiar to physicists, such as that sketched by Stoney in his well-known memoirs of 1885, 1890, and 1899, and as reasonable as the solar spectrum. The hierarchy rose in an order more or less demonstrable, from:—

1. The *Solids,* among which the Rule of Phases offers ice as a convenient example of its first phase, because under a familiar change of temperature it passes instantly into its next phase:—

2. The *Fluid,* or water, which by a further change of temperature transforms itself suddenly into the third phase:—

3. *Vapor,* or gas, which has laws and habits of its own forming the chief subject of chemical study upon the molecule and the atom. Thus far, each phase falls within the range of human sense, but the gases, under new conditions, seem to resolve themselves into a fourth phase:—

4. The Electron or *Electricity,* which is not within the range of any sense except when set in motion. Another

form of the same phase is Magnetism; and some psychologists have tried to bring animal consciousness or thought into relation with electro-magnetism, which would be very convenient for scientific purposes. The most prolonged and painful effort of the greatest geniuses has not yet succeeded in uniting Electricity with Magnetism, much less with Mind, but all show the strongest signs of a common origin in the next phase of undifferentiated energy or energies called:—

5. The *Ether,* endowed with qualities which are not so much substantial or material as they are concepts of thought,—self-contradictions in experience. Very slowly and unwillingly have the scientists yielded to the necessity of admitting that this form of potential energy—this undifferentiated substance supporting matter and mind alike—exists, but it now forms the foundation of physics, and in it both mind and matter merge. Yet even this semi-sensual, semi-concrete, inconceivable complex of possibilities, the agent or home of infinite and instantaneous motion like gravitation,—infinitely rigid and infinitely elastic at once,—is solid and concrete compared with its following phase:—

6. *Space,* knowable only as a concept of extension, a thought, a mathematical field of speculation, and yet almost the only concrete certainty of man's consciousness. Space can be conceived as a phase of potential

strains or disturbances of equilibrium, but whether studied as static substance or substance in motion, it must be endowed with an infinite possibility of strain. That which is infinitely formless must produce form. That which is only intelligible as a thought, must have a power of self-induction or disturbance that can generate motion.

7. Finally, the last phase conceivable is that which lies beyond motion altogether as Hyper-space, knowable only as Hyper-thought, or pure mathematics, which, whether a subjective idea or an objective theme, is the only phase that man can certainly know and about which he can be sure. Whether he can know it from more than one side, or otherwise than as his own self-consciousness, or whether he can ever reach higher phases by developing higher powers, is a matter for mathematicians to decide; but, even after reducing it to pure negation, it must still possess, in the abstractions of ultimate and infinite equilibrium, the capacity for self-disturbance; it cannot be absolutely dead.

The Rule of Phases lends itself to mathematical treatment, and the rule of science which is best suited to mathematical treatment will always be favored by physicists, other merits being equal. Though the terms be as general as those of Willard Gibbs' formulas, if they hold good for every canonical system they will be

adopted. The Rule itself assumes the general fact, ascertained by experiment or arbitrarily taken as starting point, that every equilibrium, or phase, begins and ends with what is called a critical point, at which, under a given change of temperature or pressure, a mutation occurs into another phase; and that this passage from one to the other can always be expressed mathematically. The time required for establishing a new equilibrium varies with the nature or conditions of the substance, and is sometimes very long in the case of solids, but the formula does not vary.

In chemistry the Rule of Phase applied only to material substances, but in physics no such restriction exists. Down to the moment of Hertz's experiments in 1887 and 1888, common-sense vigorously rejected the idea that material substance could be reduced to immaterial energy, but this resistance had to be abandoned with the acceptance of magneto-electricity and ether, both of which were as immaterial as thought itself; and the surrender became final with the discovery of radium, which brought the mutation of matter under the closest direct observation. Thenceforward nothing prevented the mathematical physicist from assuming the existence of as many phases, and calculating the values of as many mutations, as he liked, up to the last thinkable stage of hyper-thought and hyper-space which he knew as pure

mathematics, and in which all motion, all relation, and all form, were merged.

The laws governing potential strains and stresses in an ideal equilibrium infinitely near perfection, or the volatility of an ideal substance infinitely near a perfect rest, or the possibilities of self-induction in an infinitely attenuated substance, may be left to mathematics for solution; but the ether, with its equally contradictory qualities, is admitted to exist; it is a real substance—or series of substances,—objective and undeniable as a granite rock. It is an equilibrium, a phase, with laws of its own which are not the laws of Newtonian mechanics; it requires new methods, perhaps new mind; but, as yet, the physicist has found no reason to exclude it from the sequence of substances. The dividing line between static electricity and ether is hardly so sharp as that between any of the earlier phases,—solid, fluid, gaseous, or electric.

The physicist has been reluctantly coerced into this concession, and if he had been also a psychologist he would have been equally driven, under the old laws of association formerly known as logic, to admit that what he conceded to motion in its phase as matter, he must concede to motion in its form as mind. Without this extension, any new theory of the universe based on mechanics must be as ill-balanced as the old. Whatever

dogmatic confidence the mechanist had professed in his mechanical theory of the universe, his own mind had always betrayed an uneasy protest against being omitted from its own mechanical creation. This neglect involved not only a total indifference to its claim to exist as a material—or immaterial—vibration, although such mere kinetic movement was granted in theory to every other substance it knew; but it ignored also the higher claim, which was implied in its own definition, that it existed as the sole source of Direction of Form, without which all mechanical systems must remain forever as chaotic as they show themselves in a thousand nebulae. The matter of Direction was more vital to science than all kinematics together. The question how order could have got into the universe at all was the chief object of human thought since thought existed; and order,—to use the expressive figure of Rudolph Goldscheid,—was but Direction regarded as stationary, like a frozen waterfall. The sum of motion without direction is zero, as in the motion of a kinetic gas where only Clerk Maxwell's demon of Thought could create a value. Possibly, in the chances of infinite time and space, the law of probabilities might assert that, sooner or later, some volume of kinetic motion must end in the accident of Direction, but no such accident has yet affected the gases, or imposed a general law on the

visible universe. Down to our day Vibration and Direction remain as different as Matter and Mind. Lines of force go on vibrating, rotating, moving in waves, up and down, forward and back, indifferent to control and pure waste of energy,—forms of repulsion,—until their motion becomes guided by motive, as an electric current is induced by a dynamo.

History, so far as it recounts progress, deals only with such induction or direction, and therefore in history only the attractive or inductive mass, as Thought, helps to construct. Only attractive forces have a positive, permanent value for the advance of society on the path it has actually pursued. The processes of History being irreversible, the action of Pressure can be exerted only in one direction, and therefore the variable called Pressure in physics has its equivalent in the Attraction, which, in the historical rule of phase, gives to human society its forward movement. Thus in the historical formula, Attraction is equivalent to Pressure, and takes its place.

In physics, the second important variable is Temperature. Always a certain temperature must coincide with a certain pressure before the critical point of change in phase can be reached. In history, and possibly wherever the movement is one of translation in a medium, the Temperature is a result of acceleration, or its equiva-

lent, and in the Rule of historical phase Acceleration takes its place.

The third important variable in the physico-chemical phase is Volume, and it reappears in the historical phase unchanged. Under the Rule of Phase, therefore, man's Thought, considered as a single substance passing through a series of historical phases, is assumed to follow the analogy of water, and to pass from one phase to another through a series of critical points which are determined by the three factors Attraction, Acceleration, and Volume, for each change of equilibrium. Among the score of figures that might be used to illustrate the idea, that of a current is perhaps the nearest; but whether the current be conceived as a fluid, a gas, or as electricity,—whether it is drawn on by gravitation or induction,—whether it be governed by the laws of astronomical or electric mass,—it must always be conceived as a solvent, acting like heat or electricity, and increasing in volume by the law of squares.

This solvent, then,—this ultimate motion which absorbs all other forms of motion is an ultimate equilibrium,—this ethereal current of Thought,—is conceived as existing, like ice on a mountain range, and trickling from every pore of rock, in innumerable rills, uniting always into larger channels, and always dissolving whatever it meets, until at last it reaches

equilibrium in the ocean of ultimate solution. Historically the current can be watched for only a brief time, at most ten thousand years. Inferentially it can be divined for perhaps a hundred thousand. Geologically it can be followed back perhaps a hundred million years, but however long the time, the origin of consciousness is lost in the rocks before we can reach more than a fraction of its career.

In this long and—for our purposes—infinite stretch of time, the substance called Thought has,—like the substance called water or gas,—passed through a variety of phases, or changes, or states of equilibrium, with which we are all, more or less, familiar. We live in a world of phases, so much more astonishing than the explosion of rockets, that we cannot, unless we are Gibbs or Watts, stop every moment to ask what becomes of the salt we put in our soup, or the water we boil in our teapot, and we are apt to remain stupidly stolid when a bulb bursts into a tulip, or a worm turns into a butterfly. No phase compares in wonder with the mere fact of our own existence, and this wonder has so completely exhausted the powers of Thought that mankind, except in a few laboratories, has ceased to wonder, or even to think. The Egyptians had infinite reason to bow down before a beetle; we have as much reason as they, for we know no more about it; but we

have learned to accept our beetle Phase, and to recognize that everything, animate or inanimate, spiritual or material, exists in Phase; that all is equilibrium more or less unstable, and that our whole vision is limited to the bare possibility of calculating in mathematical form the degree of a given instability.

Thus results the plain assurance that the future of Thought, and therefore of History, lies in the hands of the physicists, and that the future historian must seek his education in the world of mathematical physics. Nothing can be expected from further study on the old lines. A new generation must be brought up to think by new methods, and if our historical department in the Universities cannot enter this next Phase, the physical department will have to assume the task alone.

Meanwhile, though quite without the necessary education, the historical inquirer or experimenter may be permitted to guess for a moment,—merely for the amusement of guessing,—what may perhaps turn out to be a possible term of the problem as the physicist will take it up. He may assume, as his starting-point, that Thought is a historical substance, analogous to an electric current, which has obeyed the laws,—whatever they are,—of Phase. The hypothesis is not extravagant. As a fact, we know only too well that our historical Thought has obeyed, and still obeys, some law of Iner-

tia, since it has habitually and obstinately resisted deflection by new forces or motives; we know even that it acts as though it felt friction from resistance, since it is constantly stopped by all sorts of obstacles; we can apply to it, letter for letter, one of the capital laws of physical chemistry, that, where an equilibrium is subjected to conditions which tend to change, it reacts internally in ways that tend to resist the external constraint, and to preserve its established balance; often it is visibly set in motion by sympathetic forces which act upon it as a magnet acts on soft iron, by induction; the commonest school-history takes for granted that it has shown periods of unquestioned acceleration. If, then, society has in so many ways obeyed the ordinary laws of attraction and inertia, nothing can be more natural than to inquire whether it obeys them in all respects, and whether the rules that have been applied to fluids and gases in general, apply also to society as a current of Thought. Such a speculative inquiry is the source of almost all that is known of magnetism, electricity and ether, and all other possible immaterial substances, but in history the inquiry has the vast advantage that a Law of Phase has been long established for the stages of human thought.

No student of history is so ignorant as not to know that fully fifty years before the chemists took up the

study of Phases, Auguste Comte laid down in sufficiently precise terms a law of phase for history which received the warm adhesion of two authorities,—the most eminent of that day,—Émile Littré and John Stuart Mill. Nearly a hundred and fifty years before Willard Gibbs announced his mathematical formulas of phase to the physicists and chemists, Turgot stated the Rule of historical Phase as clearly as Franklin stated the law of electricity. As far as concerns theory, we are not much further advanced now than in 1750, and know little better what electricity or thought is, as substance, than Franklin and Turgot knew it; but this failure to penetrate the ultimate synthesis of nature is no excuse for professors of history to abandon the field which is theirs by prior right, and still less can they plead their ignorance of the training in mathematics and physics which it was their duty to seek. The theory of history is a much easier study than the theory of light.

It was about 1830 that Comte began to teach the law that the human mind, as studied in the current of human thought, had passed through three stages or phases:—theological, metaphysical, and what he called positive as developed in his own teaching; and that this was the first principle of social dynamics. His critics tacitly accepted in principle the possibility of some such division, but they fell to disputing Comte's succession of

phases as though this were essential to the law. Comte's idea of applying the rule had nothing to do with the validity of the rule itself. Once it was admitted that human thought had passed through three known phases, —analogous to the chemical phases of solid, liquid, and gaseous,—the standard of measurement which was to be applied might vary with every experimenter until the most convenient should be agreed upon. The commonest objection to Comte's rule,—the objection that the three phases had always existed and still exist, together,—had still less to do with the validity of the law. The residuum of every distillate contains all the original elements in equilibrium with the whole series, if the process is not carried too far. The three phases always exist together in equilibrium; but their limits on either side are fixed by changes of temperature and pressure, manifesting themselves in changes of Direction or Form.

Discarding, then, as unessential, the divisions of history suggested by Comte, the physicist-historian would assume that a change of phase was to be recognized by a change of Form; that is, by a change of Direction; and that it was caused by Acceleration, and increase of Volume or Concentration. In this sense the experimenter is restricted rigidly to the search for changes of Direction or Form of thought, but has no concern in its

acceleration except as one of the three variables to which he has to assign mathematical values in order to fix the critical point of change. The first step in experiment is to decide upon some particular and unquestioned change of Direction or Form in human thought.

By common consent, one period of history has always been regarded, even by itself, as a Renaissance, and has boasted of its singular triumph in breaking the continuity of Thought. The exact date of this revolution varies within a margin of two hundred years or more, according as the student fancies the chief factor to have been the introduction of printing, the discovery of America, the invention of the telescope, the writings of Galileo, Descartes, and Bacon, or the mechanical laws perfected by Newton, Huyghens, and the mathematicians as late as 1700; but no one has ever doubted the fact of a distinct change in direction and form of thought during that period; which furnishes the necessary starting-point for any experimental study of historical Phase.

Any one who reads half a dozen pages of Descartes or Bacon sees that these great reformers expressly aimed at changing the Form of thought; that they had no idea but to give it new direction, as Columbus and Galileo had expressly intended to affect direction in space; and even had they all been unconscious of intent, the Church would have pointed it out to them, as it did with so

much emphasis to Galileo in 1633. On this point there was no difference of opinion; the change of direction in Thought was not a mere acceleration; it was an angle or tangent so considerable that the Church in vain tried to ignore it. Galileo proved it, and the Church agreed with him on that point if on no other. Nothing could be more unanimously admitted than the change of direction between the thought of St. Augustine and that of Lord Bacon.

Since the Rule of historical Phase has got to rest on this admission, theory cannot venture on the next step unless this one is abundantly proved; but, in fact, no one as yet has ever doubted it. The moment was altogether the most vital that history ever recorded, and left the deepest impression on men's memory, but this popular impression hardly expresses its scientific value. As a change of phase it offered singular interest, because, in this case alone, the process could be followed as though it were electrolytic, and the path of each separate molecule were visible under the microscope. Any school-boy could plot on a sheet of paper in abscissae and ordinates the points through which the curve of thought passed, as fixed by the values of the men and their inventions or discoveries. History offers no other demonstration to compare with it, and the more because the curve shows plainly that the new lines of Force or

Thought were induced lines, obeying the laws of mass, and not those of self-induction. On this obedience Lord Bacon dwelt with tireless persistence; "the true and legitimate object of science is only to endow human life with new inventions and forces"; but he defined the attractive power of this magnet as equal to the sum of nature's forces, so far as they could serve man's needs or wishes; and he followed that attraction precisely as Columbus followed the attraction of a new world, or as Newton suffered the law of gravitation on his mind as he did on his body. As each newly appropriated force increased the attraction between the sum of nature's forces and the volume of human mind, by the usual law of squares, the acceleration hurried society towards the critical point that marked the passage into a new phase as though it were heat impelling water to explode as steam.

Only the electrolytic process permits us to watch such movements in physics and chemistry, and the change of phase in 1500-1700 is marvellously electrolytic, but the more curious because we can even give names to the atoms or molecules that passed over to the positive or negative electrode, and can watch the accumulation of force which ended at last by deflecting the whole current of Thought. The maximum movement possible in the old channel was exceeded; the acceleration and concen-

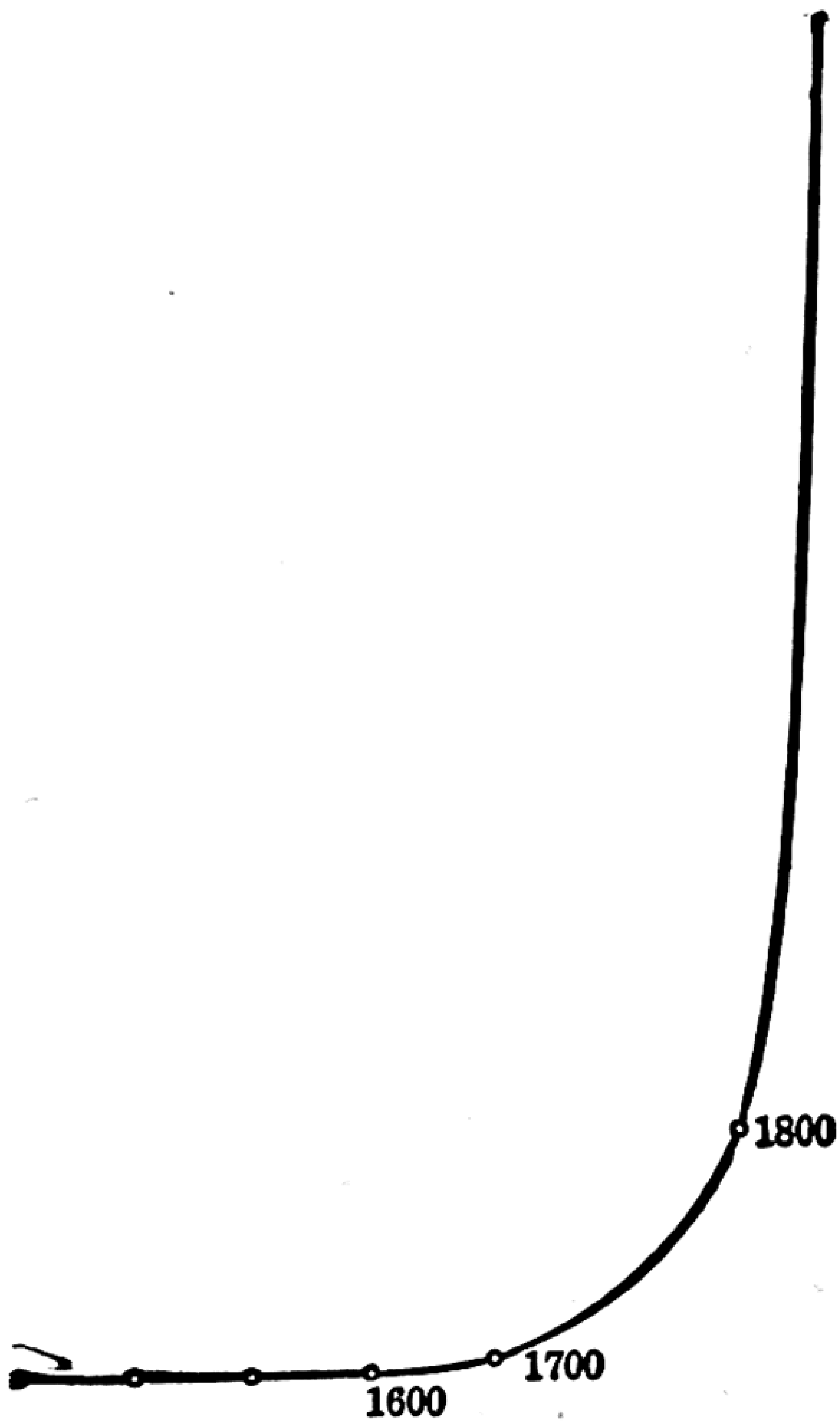
tration, or volume, reached the point of sudden expansion, and the new phase began.

The history of the new phase has no direct relation with that which preceded it. The gap between theology and mathematics was so sharp in its rapid separation that history is much perplexed to maintain the connection. The earlier signs of the coming change,—before 1500—were mostly small additions to the commoner mechanical resources of society; but when, after 1500, these additions assumed larger scope and higher aim, they still retained mechanical figure and form even in expanding the law of gravitation into astronomical space. If a direct connection between the two phases is more evident on one line than on another, it is in the curious point of view that society seemed to take of Newton's extension of the law of gravitation to include astronomical mass, which, for two hundred years, resembled an attribute of divinity, and grew into a mechanical theory of the universe amounting to a religion. The connection of thought lay in the human reflection of itself in the universe; yet the acceleration of the seventeenth century, as compared with that of any previous age, was rapid, and that of the eighteenth was startling. The acceleration became even measurable, for it took the form of utilizing heat as force, through the steam-engine, and this addition of power was measurable in

the coal output. Society followed the same lines of attraction with little change, down to 1840, when the new chemical energy of electricity began to deflect the thought of society again, and Faraday rivalled Newton in the vigor with which he marked out the path of changed attractions, but the purely mechanical theory of the universe typified by Newton and Dalton held its own, and reached its highest authority towards 1870, or about the time when the dynamo came into use.

Throughout these three hundred years, and especially in the nineteenth century, the acceleration suggests at once the old, familiar law of squares. The curve resembles that of the vaporization of water. The resemblance is too close to be disregarded, for nature loves the logarithm, and perpetually recurs to her inverse square. For convenience, if only as a momentary refuge, the physicist-historian will probably have to try the experiment of taking the law of inverse squares as his standard of social acceleration for the nineteenth century, and consequently for the whole phase, which obliges him to accept it experimentally as a general law of history. Nature is rarely so simple as to act rigorously on the square, but History, like Mathematics, is obliged to assume that eccentricities more or less balance each other, so that something remains constant at last, and it is compelled to approach its problems by means of

some fiction,—some infinitesimal calculus,—which may be left as general and undertermined as the formulas



of our greatest master, Willard Gibbs, but which gives a hypothetical movement for an ideal substance that can be used for relation. Some experimental starting-

point must always be assumed, and the mathematical historian will be at liberty to assume the most convenient, which is likely to be the rule of geometrical progression.

Thus the first step towards a Rule of Phase ror history may be conceived as possible. In fact the Phase may be taken as admitted by all society and every authority since the condemnation of Galileo in 1633; it is only the law, or rule, that the mathematician and physicist would aim at establishing. Supposing, then, that he were to begin by the Phase of 1600-1900, which he might call the Mechanical Phase, and supposing that he assumes for the whole of it the observed acceleration of the nineteenth century, the law of squares, his next step would lead him backward to the far more difficult problem of fixing the limits of the Phase that preceded 1600.

Here was the point which Auguste Comte and all other authorities have failed to agree upon. Although no one denies that at some moment between 1500 and 1700 society passed from one form of thought to another, every one may reasonably hesitate to fix upon the upper limit to be put on the earlier. Comte felt the difficulty so strongly that he subdivided his scale into a fetish, polytheistic, monotheistic, and metaphysical series, before arriving at himself, or Positivism.

Most historians would admit the change from polytheism to monotheism, about the year 500, between the establishment of Christianity and that of Mohammedanism as a distinct change in the form or direction of thought, and perhaps in truth society never performed a more remarkable feat than when it consciously unified its religious machinery as it had already concentrated its political and social organism. The concentration certainly marked an era; whether it marked a change of direction may be disputed. The physicist may prefer to regard it as a refusal to change direction; an obedience to the physico-chemical law that when an equilibrium is subjected to conditions which tend towards change, it reacts internally in ways that tend to resist the external constraint; and, in fact, the establishment of monotheism was regarded by the philosophers even in its own day rather as a reaction than an advance. No doubt the Mohammedan or the Christian felt the change of deity as the essence of religion; but the mathematician might well think that the scope and nature of religion had little to do with the number of Gods. Religion is the recognition of unseen power which has control of man's destiny, and the power which man may, at different times or in different regions, recognize as controlling his destiny, in no way alters his attitude or the form of the thought. The physicist, who affects

psychology, will regard religion as the self-projection of mind into nature in one direction, as science is the projection of mind into nature in another. Both are illusions, as the metaphysician conceives, and in neither case does—or can—the mind reach anything but a different reflection of its own features; but in changing from polytheism to monotheism the mind merely concentrated the image; it was an acceleration, not a direction that was changed. From first to last the fetish idea inhered in the thought; the idea of an occult power to which obedience was due,—a reflection of the human self from the unknown depths of nature—was as innate in the Allah of Mohammed as in the fetish serpent which Moses made of brass.

The reflection or projection of the mind in nature was the earliest and will no doubt be the last motive of man's mind, whether as religion or as science, and only the attraction will vary according to the value which the mind assigns to the image of the thing that moves it; but the mere concentration of the image need not change the direction of movement, any more than the concentration of converging paths into one single road need change the direction of travel or traffic. The direction of the social movement may be taken, for scientific purposes, as unchanged from the beginning of history to the condemnation of Galileo which marked

the conscious recognition of break in continuity; but in that case the physicist-historian will probably find nowhere the means of drawing any clean line of division across the current of thought, even if he follows it back to the lowest known archaic race. Notoriously, during this enormously long Religious Phase, the critical point seemed to be touched again and again,—by Greeks and Romans, in Athens, Alexandria, and Constantinople, long before it was finally passed in 1600; but so also, in following the stream backwards to its source, the historian will probably find suggestions of a critical point in ethnology long before such a critical point can be fixed. So far as he will see, man's thought began by projecting its own image, in this form, into the unknown of nature. Yet nothing in science is quite so firmly accepted as the fact that such a change of phase took place. Whether evolution was natural or supernatural, the leap of nature from the phase of instinct to the phase of thought was so immense as to impress itself on every imagination. No one denies that it must have been relatively ancient;—few anthropologists would be content with less than a hundred thousand years;—and no one need be troubled by admitting that it may have been relatively sudden, like many other mutations, since all the intermediate steps have vanished, and the line of connection is obliterated.

Yet the anthropoid ape remains to guide the physical historian, and, what is more convincing than the ape, the whole phase of instinct survives, not merely as a force in actual evidence, but as the foundation of the whole geological record. As an immaterial force, Instinct was so strong as to overcome obstacles that Intellect has been helpless to affect. The bird, the beetle, the butterfly accomplished feats that still defy all the resources of human reason. The attractions that led Instinct to pursue so many and such varied lines to such great distances, must have been intensely strong and indefinitely lasting. The quality that developed the eye and the wing of the bee and the condor has no known equivalent in man. The vast perspective of time opened by the most superficial study of this phase has always staggered belief; but geology itself breaks off abruptly in the middle of the story, when already the fishes and crustaceans astonish by their modern airs.

Yet the anthropoid ape is assumed to have potentially contained the future, as he actually epitomized the past; and to him, as to us, the phase to which he belonged was the last and briefest. Behind him and his so-called instinct or consciousness, stretched other phases of vegetable and mechanical motion,—more or less organic,—phases of semi-physical, semi-material, attractions and repulsions,—that could have, in the con-

cept, no possible limitation of time. Neither bee, nor monkey, nor man, could conceive a time when stones could not fall. The anthropoid ape could look back, as certainly as the most scientific modern historian, to a critical point at which his own phase must have begun, when the rudimentary forces that had developed in the vegetables had acquired a volume and complexity which could no longer be enclosed in rigid forms, and had expanded into freer movement. The ape might have predicted his own expansion into new force, for, long before the first man was sketched, the monkeys and their companions in instinct had peopled every continent, and civilized—according to their standards—the whole world.

The problem to the anthropoid ape a hundred thousand years ago was the same as that addressed to the physicist-historian of 1900:—How long could he go on developing indefinite new phases in response to the occult attractions of an infinitely extended universe? What new direction could his genius take? To him, the past was a miraculous development, and, to perfect himself, he needed only to swim like a fish and soar like a bird; but probably he felt no conscious need of mind. His phase had lasted unbroken for millions of years, and had produced an absolutely miraculous triumph of instinct. Had he been so far gifted as to foresee his

next mutation, he would have possibly found in it only a few meagre pages, telling of impoverished life, at the end of his own enormous library of records, the bulk of which had been lost. Had he studied these past records, he would probably have admitted that thus far, by some mechanism totally incomprehensible, the series of animated beings had in some directions responded to nature's call, and had thrown out tentacles on many sides; but he, as a creature of instinct, would have instinctively wished to develop in the old directions,—he could have felt no conscious wish to become a mathematician.

Thus the physicist-historian seems likely to be forced into admitting that an attractive force, like gravitation, drew these trickling rivulets of energy into new phases by an external influence which tended to concentrate and accelerate their motion by a law with which their supposed wishes or appetites had no conscious relation. At a certain point the electric corpuscle was obliged to become a gas, the gas a liquid, the liquid a solid. For material mass, only one law was known to hold good. Ice, water, and gas, all have weight; they obey the law of astronomical mass; they are guided by the attraction of matter. If the current of Thought has shown obedience to the law of gravitation it is material, and its phases should be easily calculated.

The physicist will, therefore, have to begin by trying the figure of the old Newtonian or Cartesian vortices, or gravitating group of heterogeneous substances moving in space as though in a closed receptacle. Any nebula of vortex-group would answer his purpose,—say the great nebula of Orion, which he would conceive as containing potentially every possible phase of substance. Here the various local centres of attraction would tend to arrange the diffused elements like iron-filings round a magnet in a phase of motion which, if the entire equilibrium were perfect, would last forever; but if, at any point, the equilibrium were disturbed, the whole volume would be set in new motion, until, under the rise in pressure and temperature, one phase after another must mechanically,—and more and more suddenly,—occur with the increasing velocity of movement.

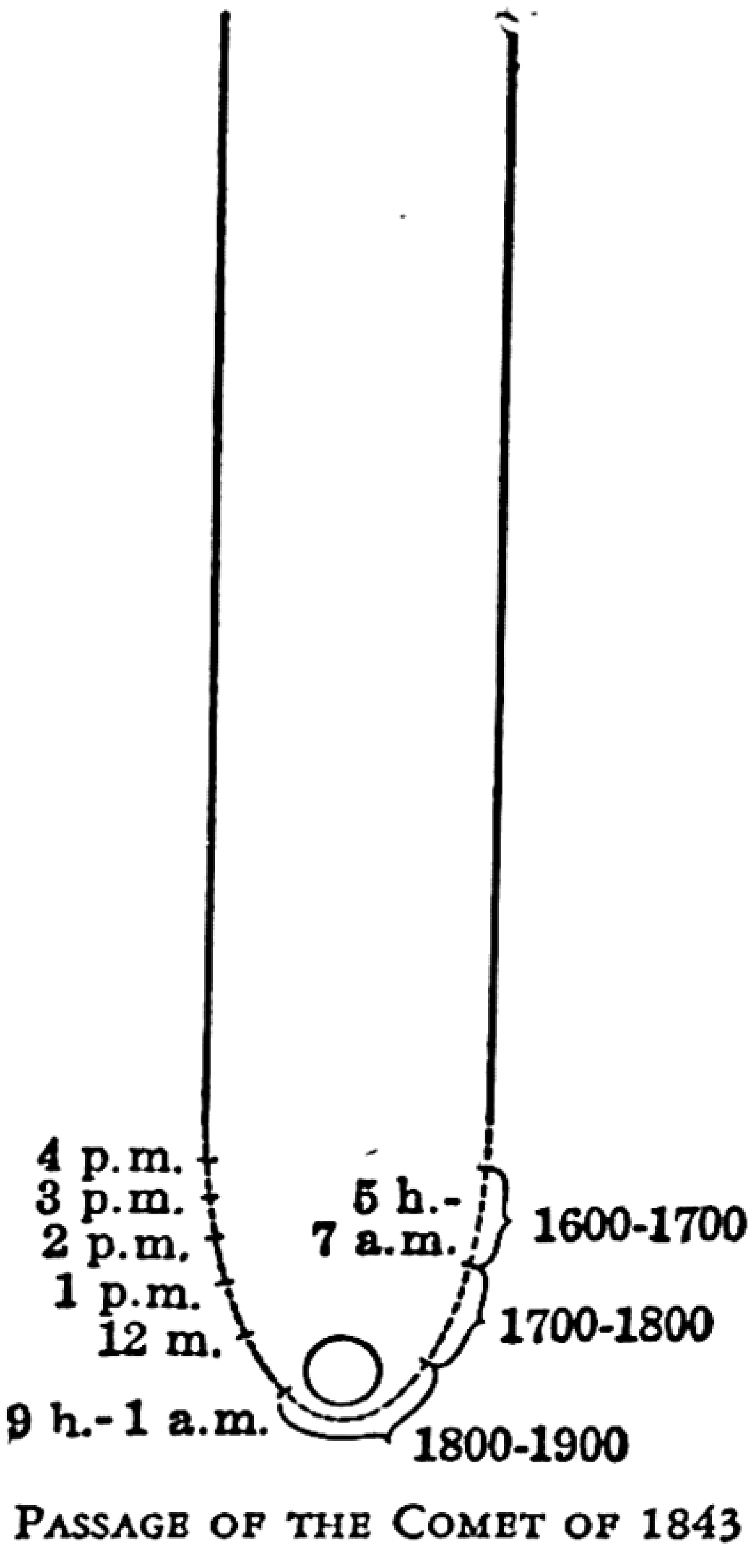
That such sudden changes of phase do in fact occur is one of the articles of astronomical faith, but the reality of the fact has little to do with the convenience of the figure. The nebula is beyond human measurements. A simple figure is needed, and our solar system offers none. The nearest analogy would be that of a comet, not so much because it betrays marked phases, as because it resembles Thought in certain respects, since, in the first place, no one knows what it is, which is also true of Thought, and it seems in some cases to be immaterial, passing in a few hours from the cold of

space to actual contact with the sun at a temperature some two thousand times that of incandescent iron, and so back to the cold of space, without apparent harm, while its tail sweeps round an inconceivable circle with almost the speed of thought,—certainly the speed of light,—and its body may show no nucleus at all. If not a Thought, the comet is a sort of brother of Thought, an early condensation of the ether itself, as the human mind may be another, traversing the infinite without origin or end, and attracted by a sudden object of curiosity that lies by chance near its path. If such elements are subject to the so-called law of gravitation, no good reason can exist for denying gravitation to the mind.

Such a typical comet is that of 1668, or 1843, or Newton's comet of 1680; bodies which fall in a direct line,—itself a miracle,—from space, for some hundreds of years, with an acceleration given by the simple formula $k\frac{M}{r^2}$, where k is the constant of gravitation, M the mass of the sun and r the distance between the comet and the centre of the sun. If not deflected from its straight course by any of the planets, it penetrates at last within the orbit of Venus, and approaches the sun.

At five o'clock one winter morning in 1843, the comet began to show deflection at about two-and-a-half diam-

eters distance from the sun; at ten o'clock it was abreast of the sun, and swung about at a right angle; at half past ten it passed perihelion at a speed of about 350 miles a second; and at noon, after having passed three hours in a temperature exceeding 5000° Centigrade, it appeared unharmed on its return course, until at five o'clock in the afternoon it was flying back to the space it came from, on the same straight line, parallel to that by which it came.



PASSAGE OF THE COMET OF 1843
February 27, twelve hours

Nothing in the behavior of Thought is more paradoxical than that of these planets, or shows direction or purpose more flagrantly, and it happens that they furnish the only astronomical parallel for the calculated acceleration of the last Phase of Thought. No other heavenly body shows the same sharp curve or excessive speed. Yet, if the calculated curve of deflection of Thought

in 1600-1900 were put on that of the planet, it would show that man's evolution had passed perihelion, and that his movement was already retrograde. To some minds, this objection might not seem fatal, and in fact another fifty years must elapse before the rate of human movement would sensibly relax; but another objection would be serious, if not for the theory, at least for the figure. The acceleration of the comet is much slower than that of society. The world did not double or treble its movement between 1800 and 1900, but, measured by any standard known to science—by horse-power, calories, volts, mass in any shape,—the tension and vibration and volume and so-called progression of society were fully a thousand times greater in 1900 than in 1800;—the force had doubled ten times over, and the speed, when measured by electrical standards as in telegraphy, approached infinity, and had annihilated both space and time. No law of material movement applied to it.

Some such result was to be expected. Nature is not so simple as to obey only one law, or to apply necessarily a law of material mass to immaterial substance. The result proves only that the comet is material, and that thought is less material than the comet. The figure serves the physicist only to introduce the problem. If the laws of material mass do not help him, he will seek

for a law of immaterial mass, and here he has, as yet, but one analogy to follow,—that of electricity. If the comet, or the current of water, offers some suggestion for the current of human society, electricity offers one so much stronger that psychologists are apt instinctively to study the mind as a phase of electro-magnetism. Whether such a view is sound, or not, matters nothing to its convenience as a figure. Thought has always moved under the incumbrance of matter, like an electron in a solution, and, unless the conditions are extremely favorable, it does not move at all, as has happened in many solutions,—as in China,—or in some cases may become enfeebled and die out, without succession. Only by watching its motion on the enormous scale of historical and geological or biological time can one see,—across great gulfs of ignorance,—that the current has been constant as measured by its force and volume in the absorption of nature's resources, and that, within the last century, its acceleration has been far more rapid than before,—more rapid than can be accounted for by the laws of material mass; but only highly trained physicists could invent a model to represent such motion. The ignorant student can merely guess what the skilled experimenter would do; he can only imagine an ideal case.

This ideal case would offer to his imagination the

figure of nature's power as an infinitely powerful dynamo, attracting or inducing a current of human thought according to the usual electric law of squares, —that is to say, that the average motion of one phase is the square of that which precedes it. The curve is thus:—

Assuming that the change of phase began in 1500, and that the new Mechanical Phase dates in its finished form from Galileo, Bacon, and Descartes, with a certain lag in its announcement by them,—say from 1600,—the law of squares gives a curve like of ice, water, and steam, running off to the infinite in almost straight lines at either end, like the comet, but at right angles. Supposing a value in numbers of any sort,—say 6, 36, 1296, —and assigning 1296 to the period 1600-1900, the preceding religious phase would have a value of only 36 as the average of many thousand years, representing therefore nearly a straight line, while the twentieth century would be represented by the square of 1296 or what is equivalent to a straight line to infinity.

Reversing the curve to try the time-sequence by the same rule, the Mechanical Phase being represented by 300 years, the Religious Phase would require not less than 90,000. Perhaps this result might not exactly suit a physicist's views, but if he accepts the sequence 90,000 and 300 for these two phases in time, he arrives

at some curious results for the future, and in calculating the period of the fourth, or electric phase, he must be prepared for extreme figures.

No question in the series is so vital as that of fixing the limits of the Mechanical Phase. Assuming, as has been done, the year 1600 for its beginning, the question remains to decide the probable date of its close. Perhaps the physicist might regard it as already closed. He might say that the highest authority of the mechanical universe was reached about 1870, and that, just then, the invention of the dynamo turned society sharply into a new channel of electric thought as different from the mechanical as electric mass is different from astronomical mass. He might assert that Faraday, Clerk Maxwell, Hertz, Helmholz, and the whole electro-magnetic school, thought in terms quite unintelligible to the old chemists and mechanists. The average man, in 1850, could understand what Davy or Darwin had to say; he could not understand what Clerk Maxwell meant. The later terms were not translatable into the earlier; even the mathematics became hyper-mathematical. Possibly a physicist might go so far as to hold that the most arduous intellectual effort ever made by man with a distinct consciousness of needing new mental powers, was made after 1870 in the general effort to acquire habits of electro-magnetic thought,—the

familiar use of formulas carrying indefinite self-contradiction into the conception of force. The physicist knows best his own difficulties, and perhaps to him the process of evolution may seem easy, but to the mere by-stander the gap between electric and astronomic mass seems greater than that between Descartes and St. Augustine, or Lord Bacon and Thomas Aquinas. The older ideas, though hostile, were intelligible; the idea of electro-magnetic-ether is not.

Thus it seems possible that another generation, trained after 1900 in the ideas and terms of electro-magnetism and radiant matter, may regard that date as marking the sharpest change of direction, taken at the highest rate of speed, ever effected by the human mind; a change from the material to the immaterial,—from the law of gravitation to the law of squares. The Phases were real: the change of direction was measured by the consternation of physicists and chemists at the discovery of radium which was quite as notorious as the consternation of the Church at the discovery of Galileo; but it is the affair of science, not of historians, to give it a mathematical value.

Should the physicist reject the division, and insist on the experience of another fifty or a hundred years, the consequence would still be trifling for the fourth term of the series. Supposing the Mechanical Phase to have

lasted 300 years, from 1600 to 1900, the next or Electric Phase would have a life equal to $\sqrt{300}$, or about seventeen years and a half, when—that is, in 1917—it would pass into another or Ethereal Phase, which, for half a century, science has been promising, and which would last only $\sqrt{17.5}$, or about four years, and bring Thought to the limit of its possibilities in the year 1921. It may well be! Nothing whatever is beyond the range of possibility; but even if the life of the previous phase, 1600-1900, were extended another hundred years, the difference to the last term of the series would be negligible. In that case, the Ethereal Phase would last till about 2025.

The mere fact that society should think in terms of Ether or the higher mathematics might mean little or much. According to the Phase Rule, it lived from remote ages in terms of fetish force, and passed from that into terms of mechanical force, which again led to terms of electric force, without fairly realizing what had happened except in slow social and political revolutions. Thought in terms of Ether means only Thought in terms of itself, or, in other words, pure Mathematics and Metaphysics, a stage often reached by individuals. At the utmost it could mean only the subsidence of the current into an ocean of potential thought, or mere consciousness, which is also possible, like static electricity.

The only consequence might be an indefinitely long stationary period, such as John Stuart Mill foresaw. In that case, the current would merely cease to flow.

But if, in the prodigiously rapid vibration of its last phases, Thought should continue to act as the universal solvent which it is, and should reduce the forces of the molecule, the atom, and the electron to that costless servitude to which it has reduced the old elements of earth and air, fire and water; if man should continue to set free the infinite forces of nature, and attain the control of cosmic forces on a cosmic scale, the consequences may be as surprising as the change of water to vapor, of the worm to the butterfly, of radium to electrons. At a given volume and velocity, the forces that are concentrated on his head must act.

Such seem to be, more or less probably, the lines on which any physical theory of the universe would affect the study of history, according to the latest direction of physics. Comte's Phases adapt themselves easily to some such treatment, and nothing in philosophy or metaphysics forbids it. The figure used for illustration is immaterial except so far as it limits the nature of the attractive force. In any case the theory will have to assume that the mind has always figured its motives as reflections of itself, and that this is as true in its conception of electricity as in its instinctive imitation of a

God. Always and everywhere the mind creates its own universe, and pursues its own phantoms; but the force behind the image is always a reality,—the attractions of occult power. If values can be given to these attractions, a physical theory of history is a mere matter of physical formula, no more complicated than the formulas of Willard Gibbs or Clerk Maxwell; but the task of framing the formula and assigning the values belongs to the physicist, not to the historian; and if one such arrangement fails to accord with the facts, it is for him to try another, to assign new values to his variables, and to verify the results. The variables themselves can hardly suffer much change.

If the physicist-historian is satisfied with neither of the known laws of mass,—astronomical or electric,—and cannot arrange his variables in any combination that will conform with a phase-sequence, no resource seems to remain but that of waiting until his physical problems shall be solved, and he shall be able to explain what Force is. As yet he knows almost as little of material as of immaterial substance. He is as perplexed before the phenomena of Heat, Light, Magnetism, Electricity, Gravitation, Attraction, Repulsion, Pressure, and the whole schedule of names used to indicate unknown elements, as before the common, infinitely familiar fluctuations of his own Thought whose action

is so astounding on the direction of his energies. Probably the solution of any one of the problems will give the solution for them all.

WASHINGTON, January 1, 1909.

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